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Advantages of Ductal Echography (DE) over conventional breast investigation: the requirement for an anatomically led breast ultrasonography (Part I)

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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 normal aspect and the findings in benign lesions the will be presentated.

Key words: ductal echography, radial breast scanning, benign lesions

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 normale şi cele din tumorile benigne în examinarea DE.

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

The breast shows a daisy-like internal arrangement, with petals (lobes) radiating around the nipple. Lobes are small oblong bags filled with a supportive tissue (connective tissue). In each lobe a grape shaped hollow structure is bored, where beads (lobules) are the milk producing units, and where the stem and its branches (ducts) form a pipe network drawing the milk towards the nipple during lactation. The internal walls of these hollow grapes are lined with a very thin epithelial layer (epithelium) that is a continuation of the skin which folds inside the breast through the pores of the nipple; hence the terms of epithelial structures or ducto-lobular structures given to these intra-lobar hollow structures [1,2].

Conventional echography (CE) is not a rational mode of investigation. The transducer is placed on the breast and slid laterally over the skin, randomly, by the operator who does not take into consideration the internal anatomic arrangement of the breast. The epithelial structures are not observed. Cancers are perceived, haphazardly in the meaningless background of the echographic field, only when they have formed an abnormality with a contrast and a volume sufficient in three dimensions to be perceptible whatever the sweeping orientation. Furthermore, this alteration in evaluated exclusively from its own geometrical aspect, regardless of the aspect of the epithelial structures of origin which are not observed. This illogical random mode of scanning, in use for twenty years, is so deficient that it has resulted in the exclusion of ultrasound as a valid means for investigating breast cancers [3] (fig 1).

Mammography presents many advantages. It is easy to perform, rapid, and provides global views of the breast. It is not dependant upon equipment which is standardized nor upon operators whose formation has been very simple. However, mammography shows a major defect. It does not visualize epithelium which is radio transparent and hidden in and by the surrounding more radio dense connective tissue. The existence of a cancer cannot be suspected until the appearance of a progressive density showing the connective reaction to the cancer, or the for-

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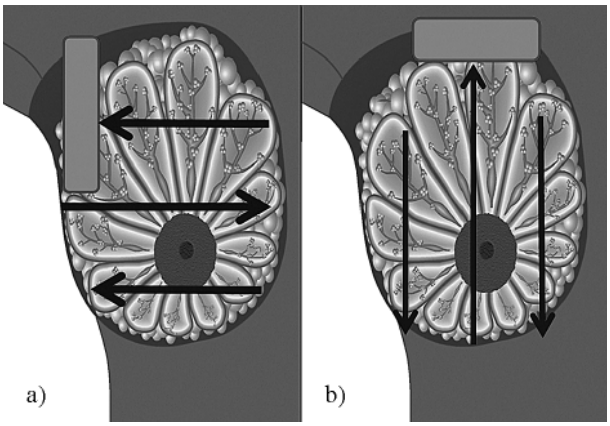


Fig 1. Conventional echography: a) transverse scanning b) sagital scanning

mation of microcalcifications. These signs are indirect and their occurrence is variable. They can allow early diagnosis of 10% of cancers, if biopsy is systematically performed in the corresponding dubious zones, which however induces very high rates of false positives (80%) and internal scars hampering follow up survey. More particularly (but not exclusively) at the early stage, mammography shows a twofold lack of reliability. It suggests cancers which do not exist, increasing the rate of inappropriate indications for surgery, and it gives a false security as it does not display existing cancers already detectable with ultrasound [3,4]. Furthermore, even when it shows pathology, Ductal Echography (DE) commonly displays alterations that were undetected. The major advantage of ductal scanning is the visualization of ducts, lobules and their content. (fig 2).

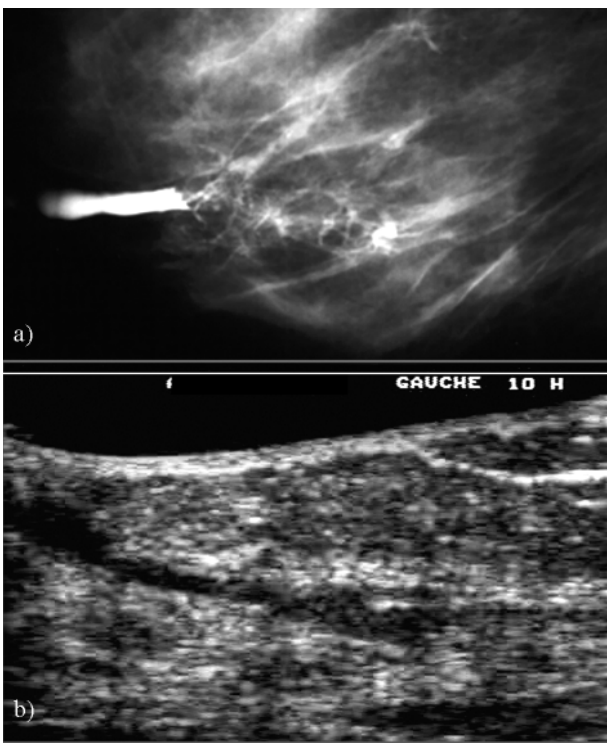


Fig 2. Comparative aspect of the mammography (a) with ductal scanning (b): visualization of ducts, lobules and their content

Ductal Echography (DE) is an anatomically led method of breast investigation based upon the identification of mammary internal structures (fig 3). The technique has demonstrated several drawbacks, in particular the requirement for a rigorous training of operators.

Radial scanning is the only technique allowing an intelligible display of the intra-lobar epithelial structures: ducts and lobules (fig 4).

DE views of the breast are only partial, which can become an important shortcoming if the probe is not long enough (6 to 8 cm) to straighten ductal structures and

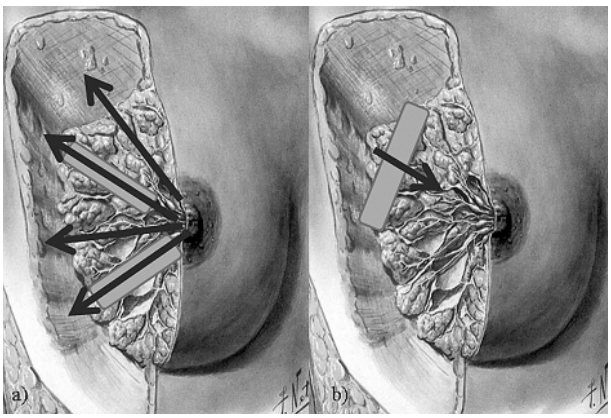


Fig 3. Ductal echography: a) radial scanning b) antiradial scanning

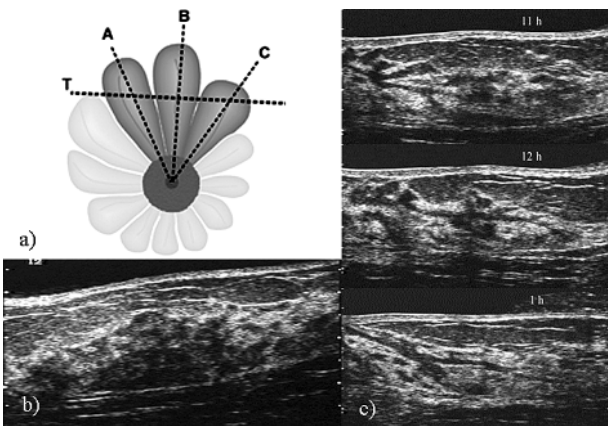


Fig 4. *a)* Drawing of the sectional plans for transverse scanning (T) and ductal scanning (A,B,C); *b)* the aspect of normal breast in transverse scanning; *c)* radial scanning of the normal breast, allowing an intelligible display of the intra-lobar epithelial structures (ducts and lobules)

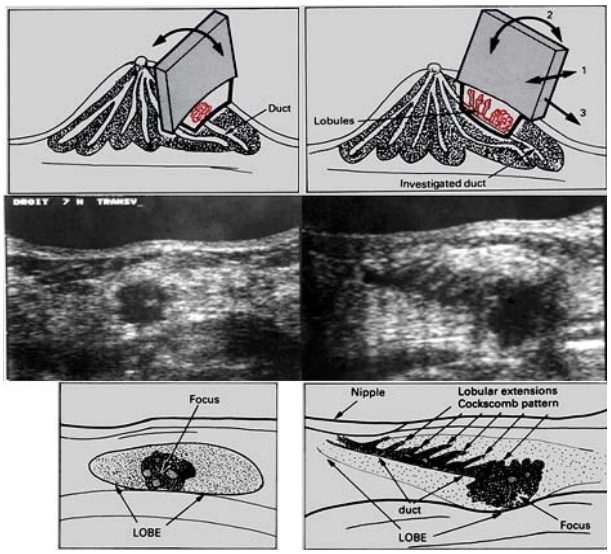


Fig 5. Probe position, echographic aspect and schematic drawing of two malignant lesions. The ductal echography evaluates both malignant lesions and their structures of origin, allowing a greater accuracy in diagnostic than with conventional echography

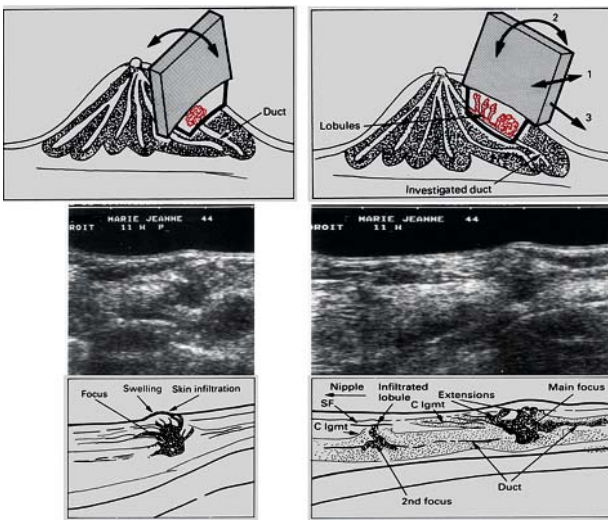


Fig 6. Probe position, echographic aspect and schematic drawing of DE in evaluation of the malignant lesions and their structures of origin: breast cancers develop along epithelial structures and DE displays millimetric lesions that are overlooked otherwise

provide long echographic fields in which long portions of lobes can be displayed and observed [5].

The difficulty of execution increases with the complexity of intralobar structures and thus, reciprocally, examinations become easier and more rapid as the internal structures show a progressive simplification within time due to the involution process of the breast (which concurrently induces also in a greater radio-transparency). Hence, DE and mammography show the same progressivity towards easier investigation with the fatty involution of the breast [2,5].

However, DE holds a decisive advantage over both mammography and conventional echography. It uses the general property of ultrasound to distinguish between epithelium (hypoechogenic) and the connective tissue (more echogenic) for providing through a convenient orientation of the transducer a direct observation of ducto-lobular structures in mammary lobes, both in fatty radio-transparent breasts and in connective radio-dense lobes. For this reason, DE has become the more efficient technique of breast investigation for women under the age of 50, where radiologists are often prevented from analyzing breast pathologies hidden within the high density of the surrounding connective tissue. For the same reason, DE is becoming also the more efficient technique of breast investigation for women over the age of 50, since substitutive hormonal therapy tends to increase breast mammographic density and cause difficulties for reading mammograms, whereas intralobar ducto-lobular structures are well perceived and analyzable with DE because their echographic display is enhanced by hormonal therapy [6,7].

This display of ducto-lobular structures allows the detection of epithelial alterations as soon as they become perceptible and the accurate guidance of a needle for withdrawing cells. Therefore DE provides a dual evaluation: a real-time visual evaluation, associating the aspect of lesions and the observation of their structures of origin to evaluate their relationship.

DE provides qualitatively and quantitatively better information than that given by X-rays.

DE is furthermore the only method allowing the diagnosis of four benign diseases of the breast that are not usually diagnosed with mammography or conventional echography: ductal ectasias, papillomatoses, adenoscleroses, and mainly hyperplasias considered as the histological transformations preceding the formation of fibro-adenomas, cysts and cancers. The identification of these diseases improves the survey of women and increases the precocity of diagnoses through a more accurate analysis of lesions and a better evaluation of their propensity to develop through comparison at shorter intervals (fig 5, 6).

Breast malignancies are not displayed by mammography but they induce a stroma-reaction and micro-calcifications which suggest malignancy. DE, by observing epithelial structures allows to use the anatomic criteria for assessing cancers and presuming the type of malignancy

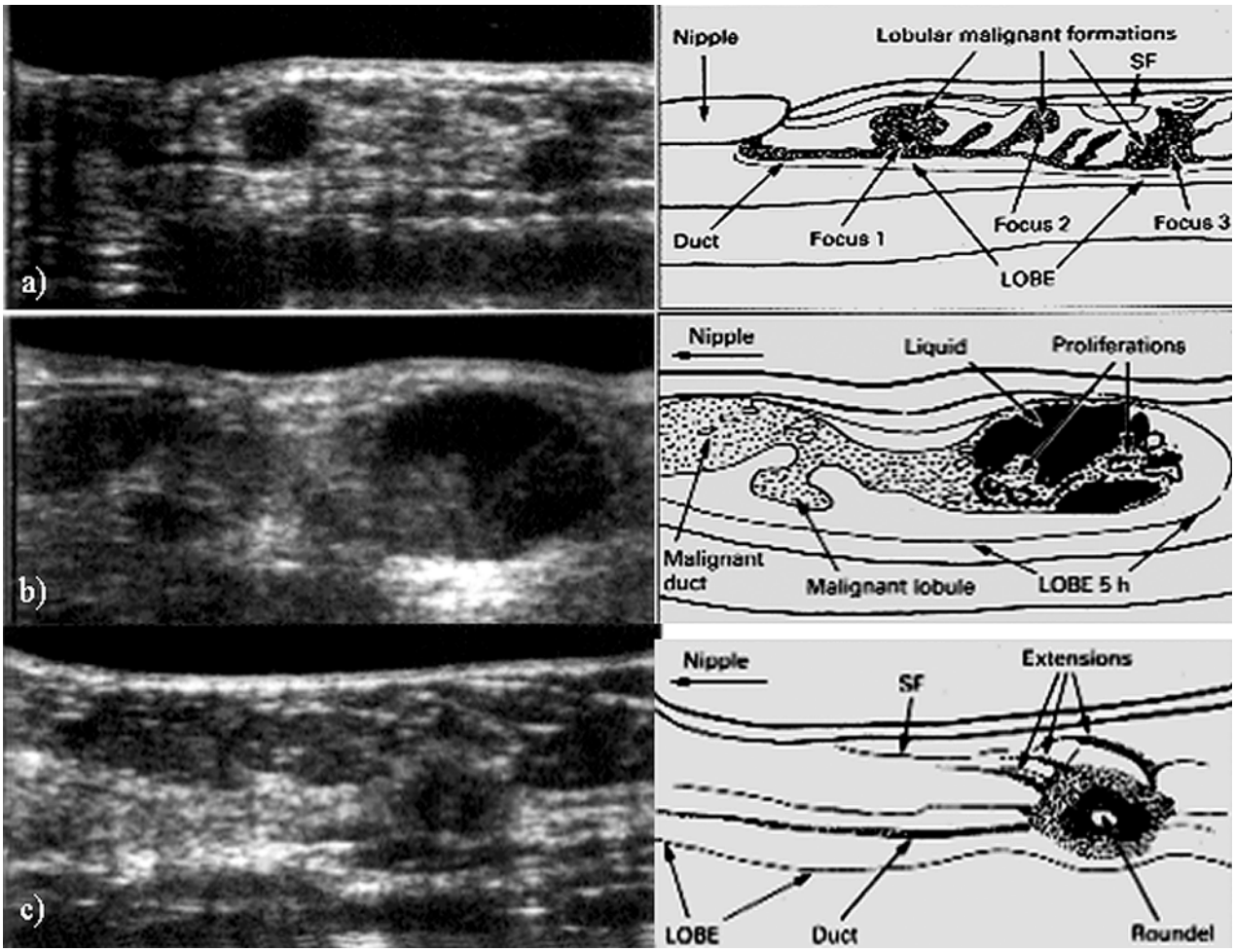


Fig 7. DE using of the anatomic criteria for assessing cancers and presume the type of malignancy: *a)* lobular (15%), *b)* diffuse (15%), *c)* focal-ductal (70%): ultrasonographic aspect (left) and schematic drawing (right)

[8,9] (fig 7). DE provides qualitatively and quantitatively better information than that given by Conventional Echography.

The use of anatomy for leading the mode of scanning the breast shows that there is much more to do in breast sonography than zigzagging the probe or crisscrossing the sweepings aimlessly over the breast, waiting for some black hole or suspicious shadow to appear (or not). By systematically watching the anatomic details, DE currently reveals and demonstrates findings that were not, in the past, expected to be detectable with ultrasound [10,11].

As pathologies develop progressively along the ducto-lobular structures, lesions are observed at different stages of evolution (fig 8). This opportunity allows a better assessment of pathologies [10,12].

In the field of collective investigation, for mass screening, examination speed is a major parameter and

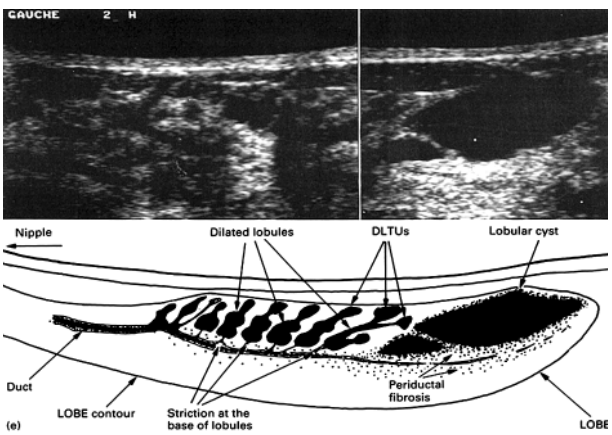


Fig 8. DE visualization of a lobular cyst, dilated lobules, striction at the base of lobules, periductal fibrosis and a dilated duct (the pathologies develop progressively along the ducto-lobular structures)

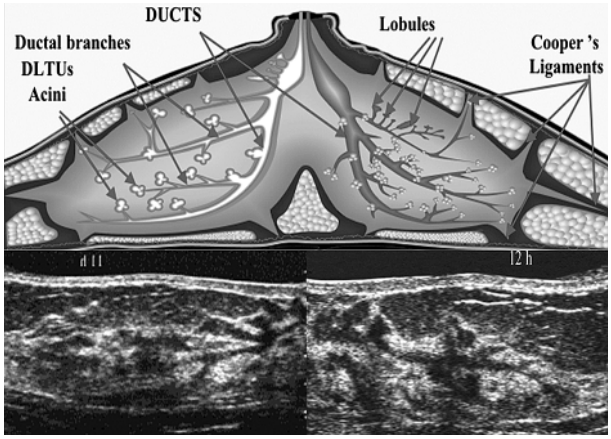


Fig 9. DE visualization of the anatomical arrangement of epithelial and connective internal structures (up – drawing of normal anatomy, down – DE aspect)

has enforced mammography for its simplicity, rapidity, and operator independency. Unfortunately, this senology, based upon the exclusive use of mammography, inevitably keeps the same important mammographic insufficiencies that conventional echography has not been able to palliate. In use now for 30 years, mammography has not resolved the problem of early diagnosis, neither statistically in the population, nor specifically for the individual investigation. Although recently higher mammographic detection rates of 'in situ' ductal cancers have been published, the fact remains that today mammography is still irrefutably fairly deficient for the reliable detection of cancers at the second half-centimeter of development (5 to 10 mm) now commonly visualized with DE.

DE is the only way to visualize the anatomical arrangement of epithelial and connective internal structures [13,14] (fig 9).

Benign diseases of the breast

They are not or very poorly displayed by mammography.

Ductal ectasias the fifth most common benign disorder are dilated structures filled with liquid, suspected upon the palpation of a worm-like soft mass behind the areola. In CE are generally not detected, neither in mammography are not radio-visible. DE demonstrates currently the possible existence of lobular dilatations (fig 10). The disease evolves mainly by thickening the duct walls and secondarily by extending the dilatation along the duct towards the extremity of the lobes. With time, the liquid content progressively shows more and more internal echoes, demonstrating the appearance of cellular debris or transformation of the liquid into a jelly consistency. Ductal dilatations are considered as a very slight risk factor for breast cancer and their presence is an indication for a systematic survey.

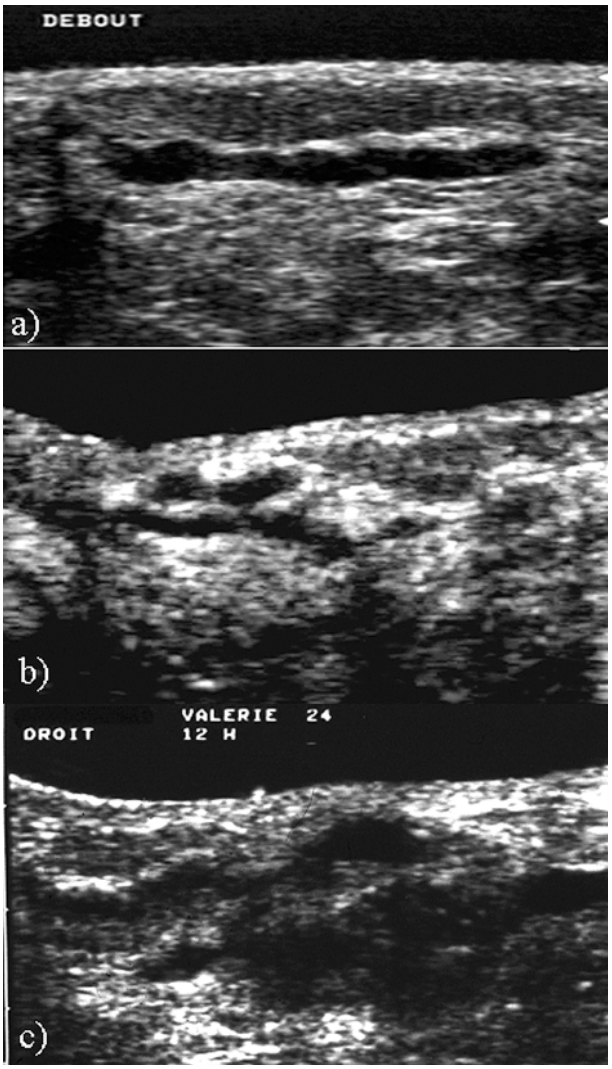


Fig 10. Ductal ectasias – three examples *(a,b,c)* of dilated structures filled with liquid. *Not radio-visible.*

Hyperplasias are dilated structures filled with cells produced by the multiplication of the cellular layers with disorientation of cells, areas of metaplasia and anaplasia and sometimes with mitoses after menopause (this is normal premenopausal). CE does not recognize hyperplasia and it is neither not radio-visible. In DE two types of hyperplasias are recognized from their appearance and location: ductal and lobular hyperplasias who can develop separately or concomitantly to form a global hyperplasia of the whole ducto-lobular structure of the lobe (fig 11). Duct walls are thickened, embossed and undulated, the pattern is one of a file of trees along a road. The next phase adds a thin central echo-free line, widened toward

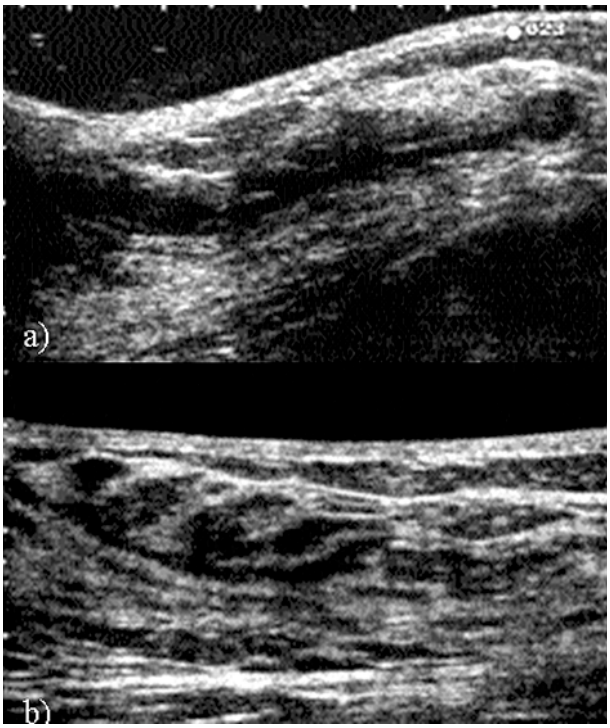


Fig 11. Hyperplasias – two dilated structures filled with cells *(a,b). Not radio-visible*

the nipple and at later phases, the lumen widens irregularly and shows alternately wide areas of liquid filling parts of the ductal system.

It was considered that the assessment of hyperplasias would provide the possibility of a better evaluation of the risk of cancer. Through the detection of "severe cytological atypia" in histologically observed hyperplasias, it was proposed to select women at a very high risk, women with "in situ" cancers and women with ongoing silent growth of occult cancers.

More recently, with new digital equipment, it has become possible in current practice to specifically visualize the zones of hyperplasia associated with early invasive cancers and allow the demonstration of Ductal Carcinomas "in situ" [11,12].

In ***fibro-cystic dysplasia,*** the most common benign disease of the breast, local dilatations are filled with liquid. The term "fibro" emphasizes the fibrotic reaction which is induced by this epithelial disease in the surrounding connective tissue. The formation of cavities as "cysts" are due to local enlargements in the ducto-lobular system and the term "dysplasia" indicates that simple benign changes have occurred in the epithelial tissue. These lesions are poorly radio-visible and not distinguished from solid lesions.

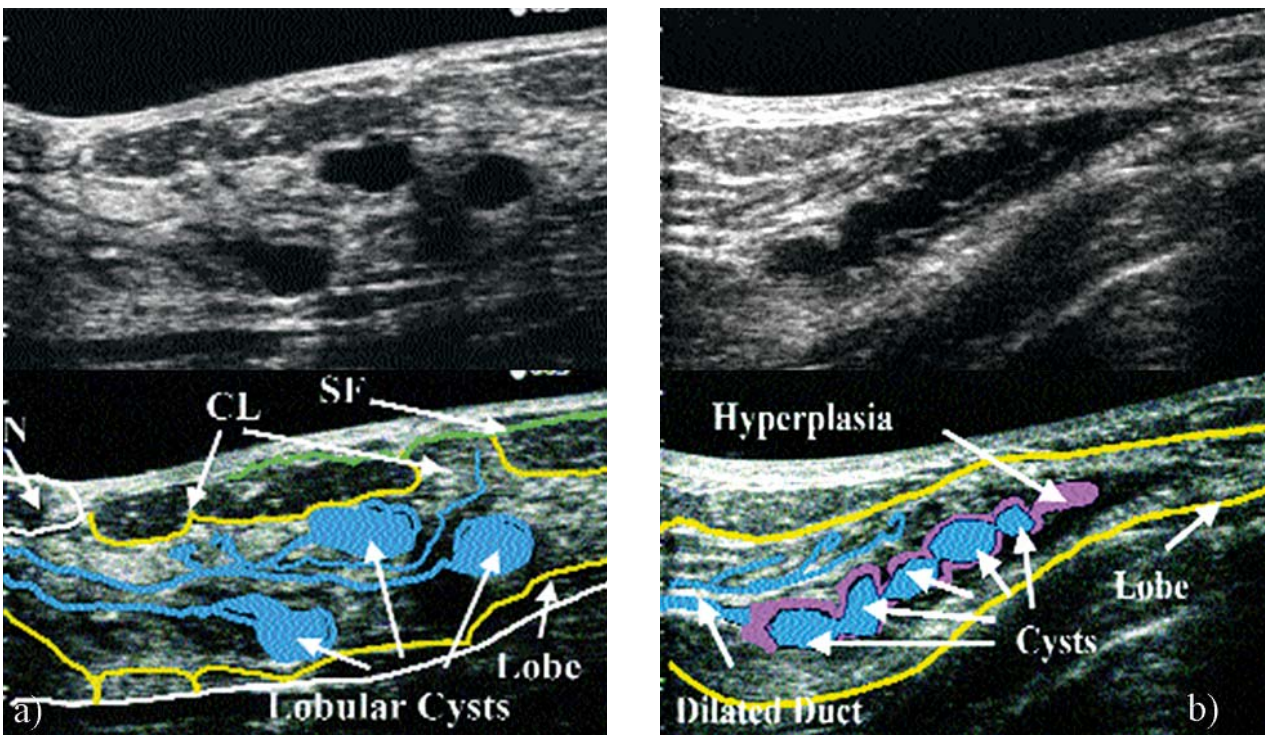


Fig 12. Fibro-cystic dysplasia- two cases of local dilatations filled with liquid, with corresponding schematic drawing *(a,b). Poorly radio-visible and non distinguished from solid lesions*

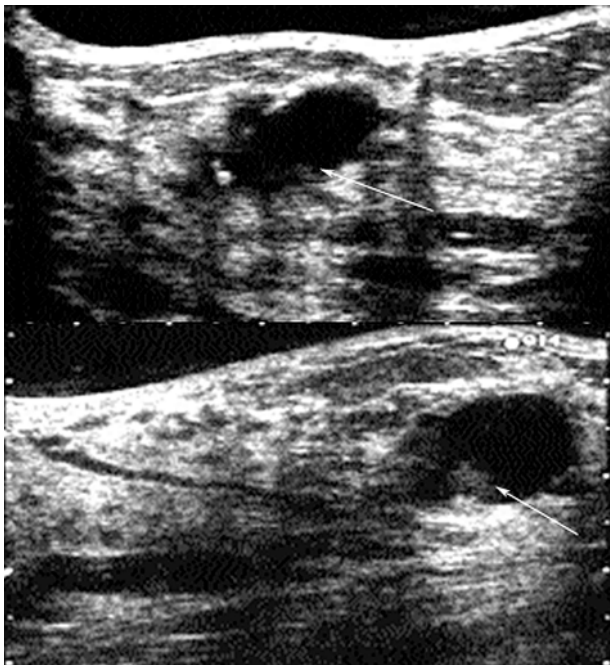


Fig 13. DE aspect of two cases with fibro-cystic dysplasia, associated with papillomas (arrows)
Details are not displayed on mammograms

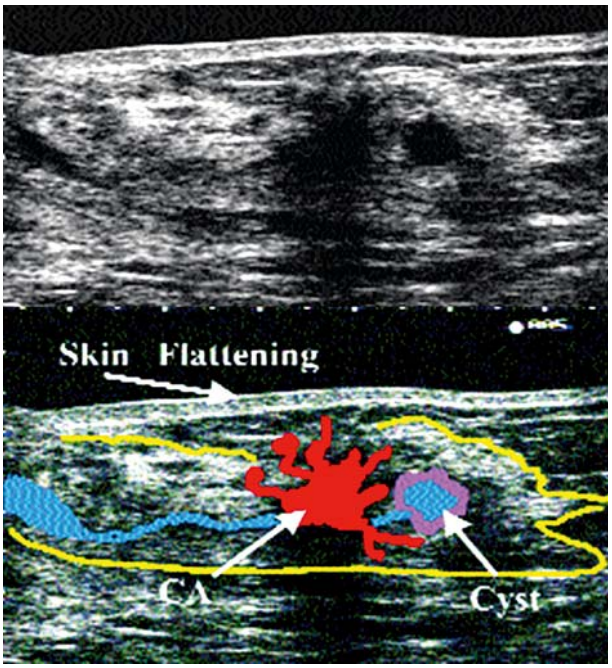


Fig 14. Fibro-cystic dysplasia associates with carcinoma (DE aspect and schematic drawing).

In DE it is possible to classify by site of origin in: ductal cysts, developed within the lumen of one or more ducts, lobular cysts, developed in lobules, usually multiple and which are a lobule type and an acini type (fig 12).

Fibrocystic disease is observed in coexistence with cancers with irregular walls, vegetations. It is now the practice in this kind of situation to perform systematic, multiple echo-guided needle aspirations. Fibro-cystic dysplasia is frequently associated with papillomas too (fig 13).

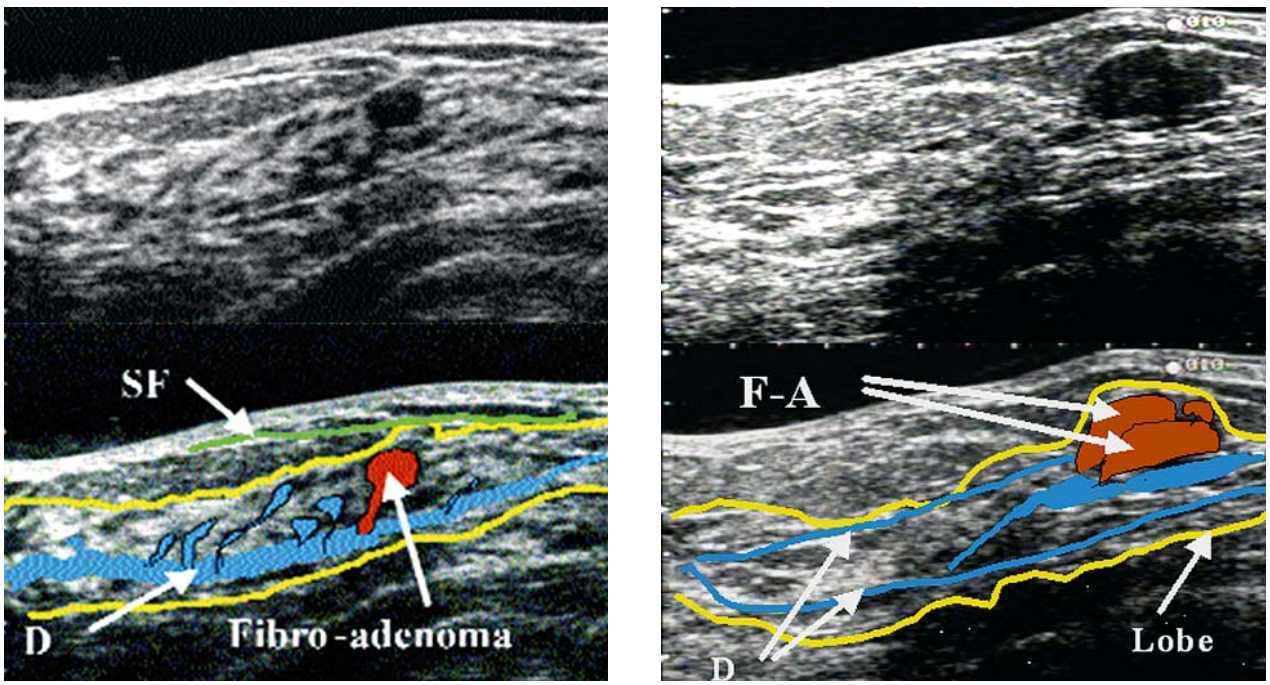


Fig 15. Fibro-Adenomas: solid lesions developing in lobules in two cases with corresponding schematic drawing *(a,b)*.
Poorly radio-visible and non distinguished from liquid lesions

Fibrocystic disease is considered to be a risk-factor for breast cancer, with a variable degree of significance: isolated cysts are considered as a minor risk for breast cancer but when fibrocystic disease is found in association with papillomatoses, intra-cystic vegetations, or adjacent hyperplasias, the situation is "complex mastopathy" and is considered as worsening the risk-factor fourfold (fig 14).`

Fibro-adenomas, the third most frequent benign disease of the breast, are solid lesions developing in lobules. They are poorly radio-visible and not distinguishable from liquid lesions. The lesion is usually diagnosed when they are between a few millimeters and a few centimeters in size. DE allows the identification of the ductal or lobular origin of fibroadenomas according to their position with regard to the display of ducts and lobules (fig 15).

Intraductal fibroadenomas are rare and rather considered as adenomas. Their localization in the duct is difficult to assess and confusion is possible with lobular fibroadenomas stuck to the superficial side of the duct. Lobular fibroadenomas are the most common type. Their lobular origin is easily demonstrated by their position alongside the duct and is confirmed by the appearance of the typical oval-shaped pattern of lobules with the thin foot plugged into the duct. DE allows a precise analysis of the composition of their patterns and a distinct observation of each of the multiple lobes entering in their composition. [11,12]. They are most often stuck together to form a palpable mass (fig 16). They can also be displayed along the ducto-lobular structures (fig 17).

Papillomas are identified as strong echogenicity enhanced areas by contrast with their liquid secretion (fig 18). Near the nipple they are responsible for nipple discharge (fig 19).

In the field of individual investigation, the advantages of DE have modified the approach to the breast, with and without mammography:

• With mammography, because, although demonstrating that mammography is a defective detection tool, DE has increased the value of dubious mammographic signs by using them to initiate efficient DE visual and sampling procedures for assessment of malignancy, with earlier and more reliable results, and the additional advantage of a possible detection of other infra-clinical and non radiovisible concomitant zones of malignancy. This improvement has shown that the discrepancy between the mammographic display and the real pathological situation as displayed by DE and confirmed histologically can be important and misleading.

• Without mammography, because DE can show radiovisible cancers and detect non radiovisible malignancies.

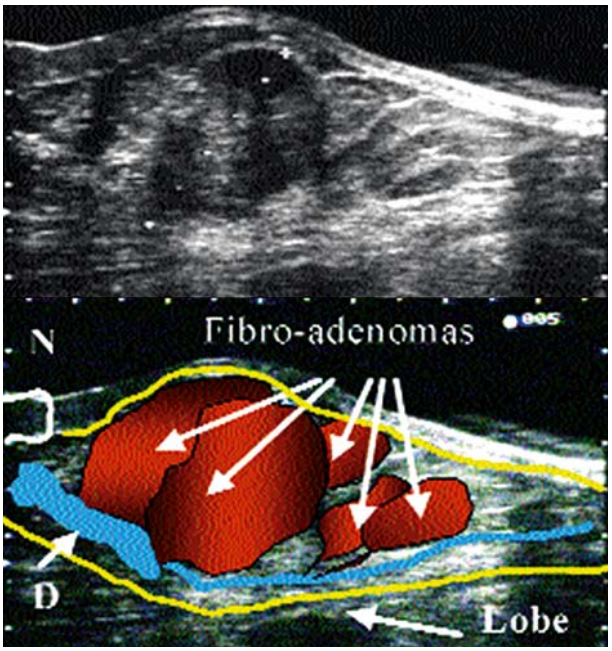


Fig 16. Multiple fibro-adenomas sticking together to form a palpable mass.

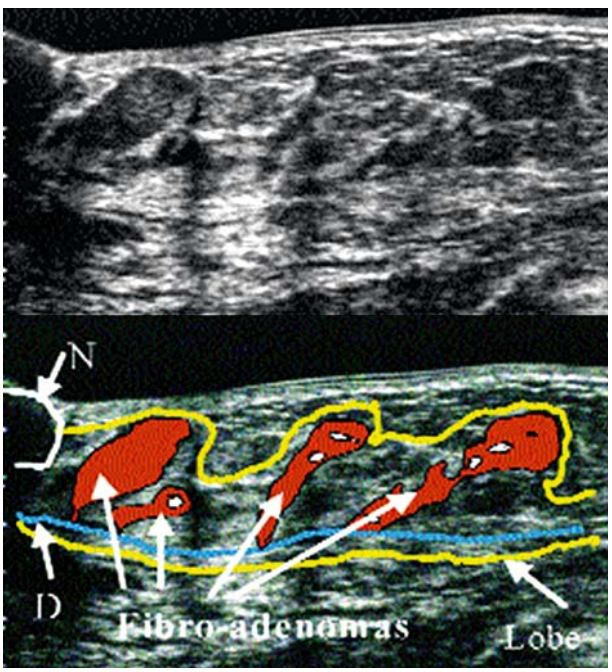


Fig 17. Multiple fibro-adenomas displayed along the ductolobular structures

Due to this advantage over mammography and its much easier execution with new digital ultrasound equipment, DE tends now to present itself as a possible autonomous means of diagnosis, aiming for an earlier, more precise, more comprehensive and more reliable evaluation of breast pathologies [15].

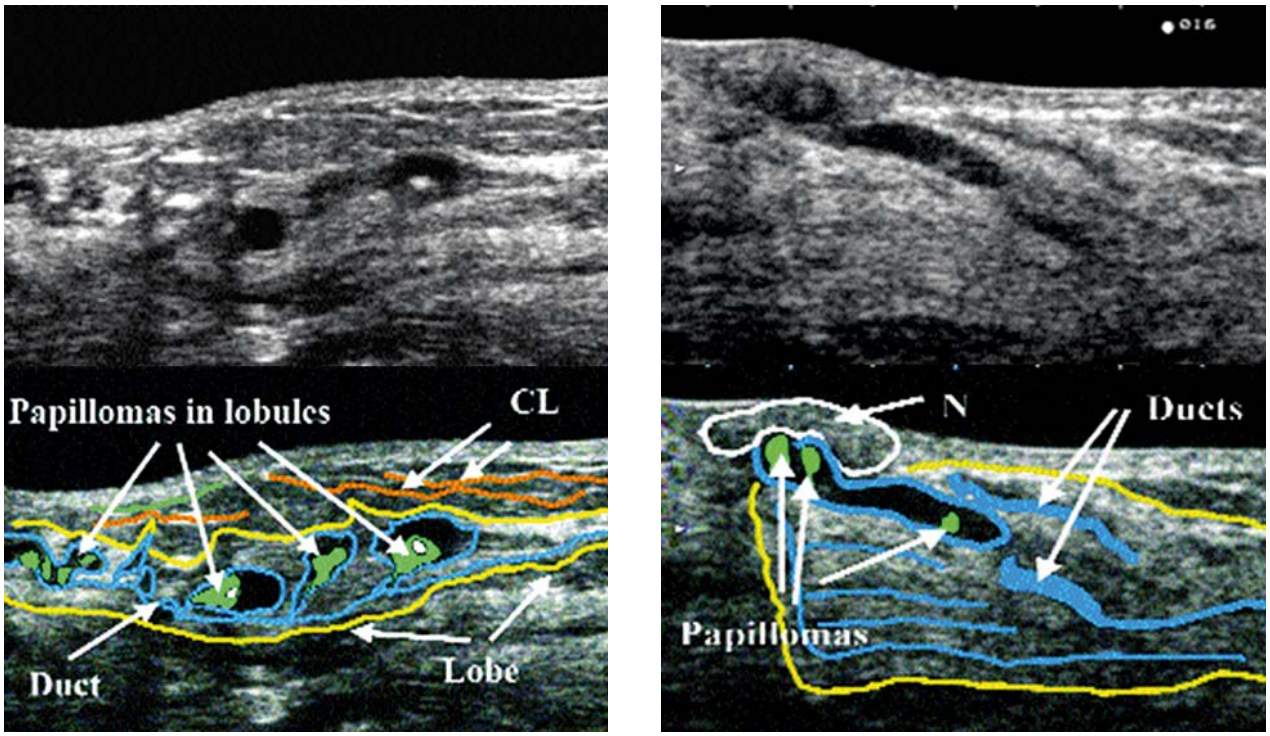


Fig 18. DE aspect of papillomas- strong echogenicity enhanced by contrast with their liquid secretion; two cases with schematic drawing *(a,b)*
Not displayed on mammograms

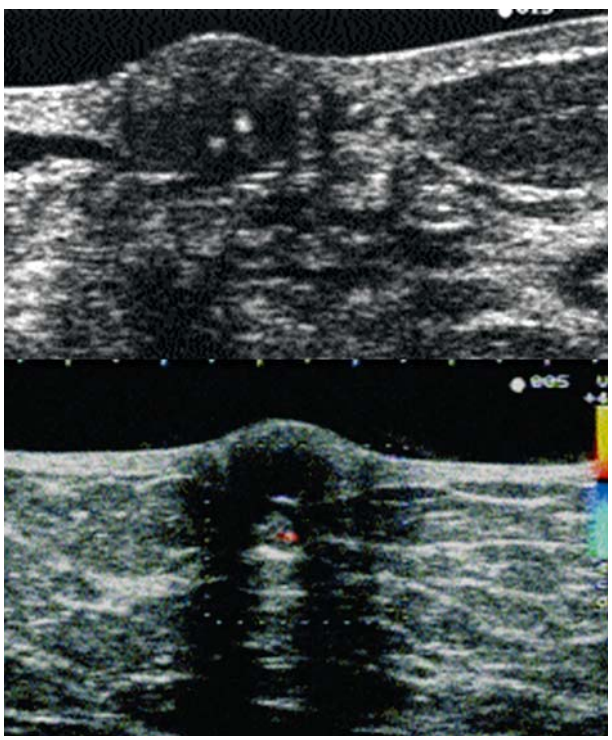


Fig 19. Papillomas situated near the nipple they are responsible for its discharge

Conclusions:

Logically, it is not possible to assess that a breast has been adequately investigated if its ducto-lobular structures have not been observed. It does not appear rational to maintain the approach to the breast exclusively upon the unreliable and disappointing imagery of mammography, galactography and irrational conventional echography. The deficiencies of conventional methods have been constantly deplored by statistical and demographic studies performed up to now. They have regularly been confirmed by DE which has commonly revealed non radio visible epithelial lesions and elucidated misleading mammographic signs in breast pathologies observed in Paris and in Rome.

Today, the use of DE and the correlative formation of operators are required:

- For highly trained operators: Admittedly, there is a real risk to overlook some small early lesions for which mammography might have displayed some clues. However, their greater expertise for identifying internal mammary features has improved their evaluation of the specificity of early epithelial abnormalities and increased their efficiency. As a consequence, this risk is widely covered by their capacity to achieve a much more frequent detec-

tion of non radio visible cancers (that are not always at an early stage, which worsens even more the appreciation of mammography). Therefore, the search for the greatest possible security implies the joint use of DE with mammography. However, experience consistently shows that diagnosis is greatly improved from mammography to DE for both detection and elaboration of the diagnosis, while it is just very slightly improved from DE to its combined use with mammography. This observation has led to recommend the yearly use of DE as the basic mode of investigation, with mammography performed every 3 or 4 years. If only a single technique is to be used, DE should be chosen when operators are adequately trained.

- For other operators, it appears preferable to still maintain the joint use of both techniques, as this reassures and provides a good means of DE formation, which has been made now much easier by the considerable progress recently brought to breast imaging by new digital equipment. This technical advance has resulted in reduced examination time, more rapid identification of breast internal features, higher reliability for the detection of early lesions and more ease for their evaluation. Therefore, operators' efficiency should rapidly increase and their greater expertise will soon have them acknowledge the preponderance of DE over mammography

- For all physicians involved in breast management, inflexibility for the exclusive use of mammography (which is the consequence of a lack of acknowledgement of DE potential) constitutes indubitably a considerable handicap for diagnosis in senology leading to unacceptable professional deficiencies.

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