MR IMAGING OF BENIGN BREAST DISEASES

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Contrast-enhanced MRI is an important supplement imaging modality for diagnosis of breast lesions. Diagnostic accuracy of MRI in evaluation of invasive ductal carcinoma in breast, in conjunction with mammography, can be achieve higher than 95%.

Indications of MRI in breast
- detection of carcinoma
- differential diagnosis of lesions
- evaluation of implant status
- mammographically dense breast
- bilateral, multifocal lesions
- postoperative, postradiation complications

Limitation
- detection or D/D of microcalcifications

Technical factors
- At present, most agreeable method is fasting 3D gradient Gd-DTPA enhanced MRI using time- intensity curve.

Interpretation criteria
1. Morphology of lesions
2. Pattern of enhancement of lesions : extent, degree
3. Time intensity curve
   - Rapid enhancement with washout
   - Gradual enhancement with washout

Rapid enhancement suggests in most cases malignant lesions
(cf. some proliferative benign diseases, fibroadenoma with abundant myxoid or adenomatous component can also demonstrate rapid enhancement)

Gradual enhancement suggests usually benign lesions.
(cf. some infiltrating ductal carcinomas, DCIS, circumscribed cancer show gradual enhancement)

MRI of Benign Lesions
- Benign, non-proliferative lesions usually show gradual minimal enhancement, whereas adenosis and proliferative benign lesions demonstrate variable enhancing features.
1. **Fibrocystic proliferation**
   ... Epithel hyperplasia with or without atypia.
   . Morphology: The lesions show ill defined, heterogenous multiple foci without surrounding rim (usually low-T1,T2).
   . Pattern: Variable, depends on histology of component
   . Enhancement: Usually gradual enhancing curve, but variable. Atypical proliferative changes can show rapid and strong enhancement but less than that of carcinoma.

2. **Inflammation**
   ... Abscess, infectious
   ... Abscess, tuberculous
cf. Inflammatory carcinoma
   . Morphology: Inflammation shows variable morphologic features depends on infectious origin. Usually ill defined, amorphic heterogenous foci with diffuse or focal thickening of skin and subcutaneous layer (low-T1, high-T2).
   . Enhancement: Abscess with underlying infectious condition in breast shows irregular marginated low signal intensity fluid content with heterogenous enhancement and thick irregular surrounding rim.
   . tuberculous abscess has variable features, nodular type, cold abscess type, diffuse-infiltrative form.

3. **Cyst / Epidermal Inclusion Cyst**
   . Morphology: sharp, smooth contour
   . Pattern: homogenous(low-T1, high-T2)
   . Enhancement: gradual enhancing nature
   Epidermal inclusion cyst shows also low signal intensity on T1WI and high signal intensity mass on T2WI, but internal content demonstrates heterogenous nature due to desquamated epithelium (whereas heterogeneous hyperechogenic mass on ultrasonography).

4. **Fibroadenoma**
   . Fibroadenoma, multiple
   . Phyllodes tumor
   . Morphology: sharp, smooth contours
   . Pattern: homogenous internal signal density (usually low-T1, high-T2, depending on internal content)
   . Enhancement (time-intensity curve): gradual enhancing nature, variable
5. Papilloma
   . Papilloma, intraductal
   . Papilloma, intracystic
Recently MR galactography has been reported as similar features that on galactography in intraductal papilloma. But if prestenotic lactiferous duct in papilloma is narrowed, it is difficult to demonstrate the ducts, even papillomatous lesion on MRI.

6. Parasites
   . Sparganosis: Sparganosis is human infestation by a larval form of an animal tapeworm, genus Spirometra. Human infestation is considered to be acquired by ingestion of water snakes, frogs, or drinking water contaminated with the larval stage of the tapeworm. Mammography usually showed multiple, lobular marginated, amorphic, solid masses without calcification. Sonography showed elongated, folded band-like hypoechoic structures in a heterogenous hyperechoic mass, which was proved to be the empty tunnel and the living worm with surrounding granuloma on pathologic examination. Hypoechoic band-like tracts in the mass suggested that tunnel where a worm had migrated because the extracted worm itself in saline solution appeared as a hyperechoic structure with sonography. On MRI worm itself demonstrated as low signal on T1WI and high signal on T2WI. If inflammation is associated to parasite infestation, diffuse heterogenous enhancement in breast parenchyma can be demonstrated.

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MAGNETIC RESONANCE IMAGING OF THE BREAST CANCERS

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The role of MRI in the detection of breast cancer and the evaluation of breast lesions is becoming better defined with the increased interest in developing ways to detect early breast cancer as well as differentiate benign from malignant lesions (Kopans, 1998). Some cancers were easily seen when distorted mass and signal void desmoplastic reactions surrounded by fat on T1-Weighted images, and cysts were easily identified due to high signal intensities on T2 images on Magnetic resonance imaging (MRI) of the breast. However, the differences in the relaxation times between normal, benign and malignant tissues are sometimes overlapped with spin echo parameters without contrast media. Therefore, Kopan in 1998 mentioned that differentiations were insufficient to provide clinical benefit for MRI without contrast material.

I. The Clinical Applications of Gadolinium Enhancement MRI

1. To determine the extent of breast cancer
2. Staging of breast cancer
3. To search for primary lesion when metastatic disease has been found,
4. Determinating the unrecognized bilateral breast cancers
5. To eliminate the possibility of breast cancer in cases with mammographic microcalcifications with lack of Gd-DTPA enhancement
6. To detect intramammary recurrence after primary conservation therapy
7. To detect local tumor recurrence in the postsurgical scar site.
8. Status of breast implant evaluation- rupture, gel bleed, associated breast cancer
9. A complementary screening modality; some clinically and mammographically occult cancers can be detected by MRI
II. Possible Problems of MRI in Breast Cancer Remain:
1. insufficient to diagnosis of small mass less than <1cm nonpalpable cancers.
2. normal tissues enhance during luteal phase and premenstrual phase
3. ductal carcinoma in situ (DCIS) may not always enhance.
4. benign lesions can enhance with problematic false positive tissues

III. MRI Techniques

A. Imaging Techniques for Breast Lesions
1. A dedicated single or double coil breast coil is preferable.
2. The patient is imaged in the prone position to reduce motion artifact.
3. Anecubital intravenous line maintained 0.5% saline with a stop-cock apparatus connected to a power-injector filled with Gd-DTPA.
4. The optimal dose of Gd-DTPA : 0.1 to 0.2 mmol per kg body weight
   Heywang-Koebrunner using 0.16 mmol/kg .
5. The injection rate with a power injector : up to 3 ml/second.
6. Uses variety of MR sequences for contrast-enhanced breast imaging
   2D FLASH
   3D FLASH (fast low-angle shot),
   FISP (fast imaging with steady precession),
   SPGR
   Echoplanar imaging (EPI)
   FATSS (fast adiabatic trajectory in a steady state),
   GRASS (gradient-recalled acquisition in a steady state)
   before and after injection with Gd-DTPA.
   chemical-shift imaging
   image subtraction of the precontrast images from the postcontrast images
   fat suppression using RODEO (rotating delivery of excitation off-resonance) pulse sequence

IV. Indication of MRI of Breast Cancers
Noncontrast MRI could easily distinguish cysts and blood products based on their T1
and T2 values and MR behavior, but the ability to detect or aid in the diagnosis of breast cancer was insufficient. Heywang and associates were among the first to demonstrate that intravenous contrast material could help distinguish an abnormality from normal breast parenchyma on MR images.

A. MR Enhancement of Breast Cancers

Almost all invasive malignancies enhance with Gd-DTPA, and with dynamic MR imaging techniques. Malignancies enhance at much more rapid initial rates (1 minutes after injection of Gd-DTPA) than benign lesions due to tumor angiogenesis. These are because that malignant lesions require a large concentration of tumor neovessels to continue growth beyond a few millimeters and to have abnormal basement membranes that cause vessel leakiness and an increase in surrounding interstitial fluid pressure. Therefore, these phenomenon made for the rapid accumulation of Gd-DTPA in breast cancers.

The morphology of the lesion and its pattern of enhancement may permit the separation of benign from malignant processes. A lesion was likely to be cancer primarily if it enhanced with high degree of enhancement, an irregular pattern of enhancement, irregular borders, and the lack of any internal septations were associated with malignancy. If the lesion was not visible after gadolinium infusion, if its borders were smooth or lobulated, if the mass was regular in shape, or if it had nonenhancing internal septations, then the lesions are likely to be benign. Several invasive cancers, including infiltrating lobular carcinomas, malignant phylloides tumors, tubular carcinoma, and colloid and mucinous carcinomas have been reported as having slow enhancement profiles.

B. MRI with Ductal Carcinoma in Situ

The MR behavior of DCIS is not clear, as enhancement varies from a rapid rate to no enhancement. This variation in enhancement behavior may be due to the variation of neovessel recruitment in DCIS. Besides Harms and colleagues, others have not been as successful because some cases of DCIS do not appear to enhance and Orel and associates were able to identify 10 of 13 lesions on the MRI scans.

Patterns of enhancement in DCIS show curvilinear enhancement ductal, segmental or regional enhancement, and peripheral in descending order. To evaluate the colleagues DCIS and contrast enhancement using the subtraction technique is better to diagnosis but rarely comedocarcinoma.
The ability of MRI to detect DCIS, particularly poorly differentiated DCIS, is important. If DCIS is not recognized extending away from a primary invasive tumor, then excision or even destroying the primary tumor will lead to high recurrence rates.

C. Tumor Staging

Tumor staging is done to determine the extent of disease within the breast, which is important to permit complete excision or tumor destruction if conservation therapy is chosen. Determining the extent of tumor involvement either multifocality or multicentricity within the breast with an imaging technique may be important to the doctors to give them an information for treatment planning. The extent of tumor involvement is not confined to staging of breast cancers. In such cases, mammography or ultrasound may not adequately delineate the tumor size and location, whereas MRI gives an excellent three-dimensional map for surgical planning.

D. Differentiation of Postoperative Scar from Cancer Recurrence

Some of these patients undergo reexcision of the scar due to the concern for local recurrence, although local recurrence only occurs in 1% each year.

MRI may be useful in distinguishing scar tissue from local recurrence at the specified postoperative time interval. Although immediately after surgery and during the course of radiation therapy a high density of new vessels from wound healing can result in enhancement on MRI. Areas of surgery frequently enhance within 6 to 12 months after treatment. After that period of healing, fixed fibrosis does not enhance, but recurrent breast cancer frequently does. If any enhancement is visualized in a scar older than 12 months, the possibility of recurrence increases. Although the early detection of recurrence in the breast may have useful therapeutic value, it has yet to be shown that detecting recurrences earlier alters mortality. Nevertheless, in the absence of data, early detection of recurrent breast cancer would seem to be a good idea.

E. Other Applications

Chest wall imaging, searching for a primary malignancy, and following the response of breast cancers to chemotherapy are other areas in which some physicians find MRI of the breast to be useful. The detection of chest wall recurrence may be a problem after mastectomy and reconstruction with an implant or a TRAM (transverse rectus abdominis myocutaneous flop) procedure. As noted earlier, we and others have found MRI to also be
useful for searching for a primary breast cancer in patients with metastatic disease of unknown origin or in those with axillary adenopathy highly suspicious for a breast malignancy.

The evaluation of local tumor response to chemotherapy with MR breast imaging may also provide useful information to oncologists or surgeons.

**F. Future of Breast MRI**

At present, MRI of silicone implants has a defined role in the evaluation of implant rupture. Contrast-enhanced MRI of the breast is also useful in solving specific problems, such as distinguishing scar from cancer recurrence 12 or more months after surgery and in local staging of breast cancer.

MRI is also useful in searching for a primary breast cancer when the patient presents with metastatic disease.

Differentiation of benign from malignant breast disease with dynamic MRI remains an area of research. If successful, MRI could reduce the number of biopsies for benign lesions and could possibly provide a means for earlier cancer detection in a limited group of patients.

Because of its cost, the need to inject contrast material, and the complexity of the examination, MRI is not likely to be a universal screening test. Nevertheless, MRI may be useful to screen selected groups of patients with mammographically dense and complex breast tissue or those at very high risk for developing breast cancer.

Because of its high sensitivity and ability to image small lesions, but its still rather low specificity, methods to guide tissue diagnosis and localization of MRI-detected lesions are necessary. These lesions may not be seen with mammography or sonography, and methods need to be devised to guide needle localizations, fine-needle aspiration, and core biopsies with MRI. Researchers have developed methods to guide needle procedures with MRI, but they remain fairly cumbersome.

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PITFALLS IN DYNAMIC MR MAMMOGRAPHY

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For 15 years now MR Mammography (MRM) has been clinically tested. In the early phases there was no agreement as to the value of this method because of the multitude of different measurement possibilities. The considerably worse spatial resolution as compared to x-ray mammography, the inability to detect microcalcifications and the high price of the method, plus the necessity to inject a contrast medium were all considered to be major disadvantages. Because of these disadvantages, many experienced mammography experts regarded this method with great skepticism in the beginning.

Since then, however, numerous publications have shown that MRM yields the highest sensitivity in the diagnosis of early and small breast cancers and that in particular the multifocality of breast cancers can be adequately recognized only with this method (1, 6, 7, 9-11, 19, 20, 24-26, 28-42, 44, 45, 50, 54, 56, 57). The utility of contrast medium enhanced MRM can be explained by the generation of early tumor angiogenesis, which probably represents a very reliable sign of a breast tumor with a size of 3 mm or greater. Such a tumor needs an increased blood supply for nourishment and removal of metabolic waste materials in order to grow uncontrollably (4, 12-14, 55, 60).

There appears to be increasing consensus that for an exact diagnosis of breast cancer the selection of the temporal resolution (e.g. a so-called „dynamic technique“) is of the utmost importance (3, 6, 10, 15, 17, 19-22, 28-43, 46-49, 53, 57-59). After several minutes the differences between benign and malignant lesions are noticeably reduced because of the overlapping signal increases. Imaging sequences of 4 minutes or longer yield significantly reduced specificities as compared to measurement durations of a maximum of 1 minute.

The data now available from all study groups show that the dynamic MRM has the highest sensitivity in the diagnosis of early stage breast cancers. It can also be expected that with a routine use of MRM, the high mortality of breast cancer patients, especially in younger women (premenopausal), may be reduced. The uniform initial signal increase of the breast cancer can be best explained in terms of the tumor angiogenesis of malignant tumors. The nondetection of microcalcifications by MRM is not a serious disadvantage, because microcalcifications appear in only a minority of cancer cases. In the actual patient group the negative predictive value was 99.8 %. The dynamic MRM can therefore detect a carcinoma with high sensitivity and almost with certainty eliminate the possibility of such a diagnosis. For this reason, the expectation is justified that in the future MRM could be a
major contributor to the elimination of unnecessary biopsies and surgery. While the high sensitivity of MRM in the detection of small carcinomas (3 mm - 10 mm) has been verified internationally, there is still debate upon the different specificities of the various MRM methods, in other words, the number of false-positive findings. As criteria for malignancy, previously only an initial signal increase of more than 90% in the vital nonnecrotic areas of the tumor and only according to the measurement conditions mentioned was reported and evaluated. The exact analysis of further signal changes after the first 2 minutes following the injection of the contrast medium appears, however, to be helpful for the differential diagnostic evaluation. All carcinomas and only the carcinoid showed either a very strong increase and after more than 2 minutes a constant or decreasing signal intensity, while the other benign and false-positive findings showed a progressive further signal increase over the entire time frame of the dynamic evaluation.

Aside from the histologically assured carcinomas, only the carcinoid has shown such a characteristic signal curve. The signal decrease can be explained in terms of the early elimination of the contrast medium („washout“) from the breast, possibly due to av-shunts induced by tumor angiogenesis. This early washout-effect seems to be the most reliable sign of malignancy in MR Mammography.

The detailed analysis of the myxoid fibroadenoma yields further clues for a benign process: the initial signal increase within the first minute is in accordance with standard measurement conditions and relatively uniform in a typical range [e.g. between 90-120 %, when a 2D-FLASH (100-5-80) sequence is used for cancers] while myxoid fibroadenomas often exhibit a strong signal increase of more than 120 %. The maximum signal increase of the carcinoma is reached in the vital area of the tumor in the periphery, while in the center of the tumor necrotic or hyalinotic areas are usually found with a lower signal increase. By contrast, one also finds maximum increase values in the center of the mass in myxoid fibroadenomas. Moreover, fibroadenomas are in most cases surrounded by signal poor membranes or can exhibit septations within the lesion, which are usually not seen in carcinomas. An abscess can be identified by means of additional T2-weighted images and via the anamnensis. The majority of patients reported a prior cyst puncture.

Two MRM suspected carcinomas were identified as normal in the histopathologic examination. Both of these patients are now in follow-up-control. It is possible that both of the small lesions of respectively 6 and 8 mm were not found. Because there are no sufficiently clinically tested MRM biopsy procedures today, MRM measurements must be used to guide the standard biopsy procedure. The localization of the mass is given in a three-dimensional rectangular scheme, in which the breast is viewed as a half-sphere, with the nipple on the top. A lesion is described as x mm medial or lateral, y mm cranial or caudal, and z mm dorsal in relation to the nipple. Because biopsies are usually carried out
with the patient in a supine position, in contrast to a MRM examination, the breast must be held in an upright „anti-asymmetric“ position, most effectively with the help of a suction device. It is extremely important to ensure that the lab technician prepares the specimen with the thinnest histopathologic sections. In routine pathologic diagnosis, sections of every 5 to 10 mm of a specimen are prepared, often resulting in an inability to detect small cancers of less than 5 mm.

In order to detect possibly very slow growing cancers, all masses with a signal increase of more than 70 % within the first minute (according to the imaging conditions mentioned above; for other imaging sequences other threshold values may apply!) should be examined histologically. Previously, such cancers were described only individually by others under different measurement parameters, but in the own patient group only in two cases of in-situ-cancers.

The signal intensity of a lesion in the first postcontrast image 1 minute after the injection of the contrast medium depends on a number of factors:

Among the factors relating to the patient include, for example, the position of the arm, which should be stretched across the body and not crossed behind the head. Crossing the arm behind the head leads to a delayed inflow of the contrast medium through the body and a slower signal increase. A paravenous or partial paravenous position of the cannula can yield false results of a slow growing tumor. The heart circulation time also influences the characteristics of the signal.

Although, up to now, there have not been any false-negative diagnoses of cancer on account of this parameter, so this aspect probably must be considered in the future. However, for dynamic measurements in shorter time intervals the cardiovascular situation should be considered. Possibly, the evaluation of the intensity in the aorta is a more exact parameter of the inflow behaviour.

The injection technique, on the other hand, is of great importance. The contrast medium is injected in a dose of 0.1 mmol/kg body weight as a bolus (within 10 seconds) with a following bolus of 20 mL physiologic saline in order to facilitate a complete inflow of the contrast medium from the tubing into the antecubital vein. In case a vein on the back of the hand or a radial vein is used, a higher injection of saline (30 mL) must follow. Only then does the dynamic measurement begin.

Most investigators use a contrast medium dose of 0.1 mmol/kg Gd-DTPA. The sensitivities mentioned were obtained with this dose and with higher dosages. However, the specificity is noticeable lower with higher concentration of contrast medium, as the
A diagnostic window, that considers the different contrast medium enhancement from benign and malignant lesions, is correspondingly shortened by a higher dose.

In the first years of dynamic examination technique (1986-1990) it was necessary to account for a „loading time“, in other words a time span between the initiation of the postcontrast imaging sequence and the start of actual data acquisition. At that time, after the initiation, the computer had to search for available storage in the imager before the data acquisition could begin. This lasted between 10-60 seconds. With the modern machines available today the loading times are virtually zero, so that the data acquisition begins immediately with the push of a button on the console. Strictly speaking, a short waiting period of approximately 20 seconds should be observed, in order to compare today’s images with those of a few years ago. An immediate start of the postcontrast images could theoretically lead to more false-negative results, according to the 90 % rule. In no case the measurement should be started before the contrast medium and salt solution are injected.

The choice of the appropriate imaging technique is an exceptionally important factor. Other imaging techniques (for example 3-D gradient echo sequences) lead to other initial signal increases. The signal increases for 3-D sequences (i.e., 3-D FLASH 25/5/80) are, for example, 189 % in carcinomas after 1.7 minutes (34). The signal changes of different measurement sequences cannot be compared directly with each other. The signal increase is higher for 3-D sequences than 2-D sequences and stronger in longer repetition times than in short repetition times (34). These differences are possibly caused by the various slice profiles of 2-D and 3-D gradient echo sequences. Gradient echo sequences should be preferred to spin echo sequences due to the stronger contrast effect (29-31, 37, 42). Depending on the field strength, certain echo times will result in image contrasts of fat and water protons within the voxels being either „opposed“ or „in-phase“. The echo time should be chosen so that no extinction occurs in the interfacial zone between fat and water containing tissues (2).

The comparison of the signal values to a single reference substance (fat tissue or phantom) is not sufficient for the purpose of comparative analysis. In the future, several standardized and durable test solutions with different T1-times (34) should be used, so that the signal increase can be compared when imaging is performed with different instruments and under varying conditions. While high sensitivity of over 95 % for the detection of breast cancers with a field strength of at least 1.0 Tesla has been proven on many patients, the value of MRM with medium and low field strengths is noticeably smaller because the T1 relaxation time of breast tissue for 0.5 Tesla is only 600 msec compared to 960 msec for 1.5 Tesla. The T1 shortening via the contrast medium is therefore relatively smaller for lower field strengths. This disadvantage must be equalized via the use of other sensitive imaging sequences.
The time intervals of the post contrast images are a further factor of great importance. Malignancies often exhibit a „washout effect“ as mentioned above, or in other words, a decrease of the signal intensity after a few minutes. A time of measurement of several minutes would possibly not designate such a mass as a carcinoma, a false-negative evaluation because with such a long time of measurement the medium signal intensity over the entire time period would be measured. A benign lesion (with a slow progressive signal increase) on the other hand would be designated a carcinoma, a false-positive result, with such a sequence, because after a few minutes, a high signal intensity is reached. The consideration of the temporal change of the signal characteristic is one of the most important criteria in breast diagnosis. Relatively long imaging times of several minutes yield considerably lower specificities than imaging times of 1 minute.

Because the imaging technical parameters, such as pulse sequence, field strength, temporal resolution, dose and injection technique of the contrast medium etc., partially influence the image information considerably stronger than pathophysiologic factors, every imaging technique must be calibrated in order to yield the characteristic signal changes specific for that technique.

Relatively high signal increases can occur in the medial and lateral glandular parenchyma in the inflow area of the A. thoracica interna as well as the lateralis. This effect can be seen through the symmetry and morphology of the enhancing area in the outer regions of the breast. Isolated, focal, unilateral initial signal increases over the threshold value, however, should be diagnosed as carcinomas. Generally, vessels should not be misdiagnosed as enhancing lesions; usually they can be identified by the „inflow-phenomenon“, i.e., a higher signal intensity in the precontrast scan, and by the anatomic sections in neighboured slices or other orientations. If there is still any doubt, an MR angiography sequence (e.g., a „time-of-flight“ sequence) can be performed.

In order to avoid false-positive and false-negative results, the examiner must be familiar with the large number of artifact possibilities. As an example only the problem of the coil adjustment will be discussed. In case the tuning and matching of the coil are not accomplished optimally, only a more or less large segment of the transmitted NMR signal is received. This segment in no way correlates to the signal intensity under optimal adjustment or to physiologic parameters such as T1 or T2 times. In case of an incorrect coil adjustment the signal intensity in the glandular parenchyma is often atypically low, almost black. Such low signal values are usually measured in air, water, or bone but not in the glandular parenchyma of the breast under these conditions of measurement. Percentage signal changes are no longer in a diagnostically valuable relation to the precontrast image. The signal intensity in the glandular parenchyma of the precontrast image should be
sufficiently high and relatively constant in all areas of the breast. Only then measurement errors caused by incorrect adjustment can be avoided to a large extension. Another technical problem is the inconsistency of the receiver adjustment during the dynamic measurement. The signal intensity of the glandular parenchyma and the fat tissue varies from minute to minute, so that a quantitative evaluation is of no value.

MR mammography is still a research technique. Despite promising results in the detection and especially in the exclusion of a cancer, the enormous variety of pitfalls has to be clarified and evaluated. Furthermore, histopathologic questions have to be solved. Obviously, MRM can detect a tumor specific sign, i.e., the changed neovascularization due to tumor angiogenesis. A cancer in a size of more than 2 mm needs such a neovascularization in order to be able to grow independently. Strictly, this represents a biologic limit of MRM: earlier stages like carcinoma in-situ (CIS) do not necessarily need a tumor angiogenesis. Data in the literature vary between 10 and 90 % and it is presently undetermined how many CIS cases can be detected by MRM. On the other hand, CIS is very frequent: Danish studies revealed signs of intraductal or invasive cancers in 25 % of all women (!) in postmortem studies, whereas only 7 % of these women had suffered from clinical symptoms of breast cancer during life time. That means that about 18 % of all women showed clinically occult signs of breast cancer which were prognostically irrelevant.

The main aim of breast cancer diagnosis is the reduction of mortality, i.e., a detection of invasive breast cancers as soon as possible and before metastases have been developed. It seems possible that this demand can be fulfilled by MRM. However, in the present state the procedure is definitely not advanced enough, controversially discussed in technical and methodological aspects, not present in the routine experience of doctors and still questioned concerning the problems of specificity.

The high costs of MRM must be reduced by the development of cheaper devices and techniques. Generally, additional costs in diagnosis should be counterbalanced with costs of „unnecessary“ biopsies or diagnosis made too late, not to mention the reduced psychologic stress of the patient.

The number of false-positive findings can be reduced by the use of additional image parameters such as morphology, „cancer corner“ or „wash-out effect“ and T2 images. Numerous artifact possibilities demand a high level of experience on the part of the examiner. Because the imaging parameters influence the image information more considerably than pathophysiologic mechanisms. Every imaging technique must be tested in order to yield the characteristic signal changes of malignant and benign lesions for the selected imaging technique. The highest specificity possibly is extremely important,
because a majority of false-positive x-ray findings will no longer be biopsied or operated on in the future as a result of MRM analysis. In this manner, considerable costs can be saved.

The present indications of MR mammography under ideal technical conditions seem to be the following:

1. The exclusion of an invasive cancer with a size of more than 2 mm seems to be possible.
2. The question of multifocality and/or multicentricity of breast cancer can be answered more precisely by using MRM.
3. The differentiation between benign and malignant lesions depends largely on technical parameters and on the experience of the examiner.
4. The differentiation between tumor and scarring after biopsy, operation, prothesis implantation seems to be possible.

However, before MRM can be recommended as routine procedure several questions have to be answered, including the following:

1. How can the high costs be reduced?
2. Are special MR-devices available with the same accuracy as today’s „high-tech“-machines? Can low-field systems be used in the reliable evaluation of small breast cancers as well?
3. Which dose of contrast medium is the best for which measurement technique?
4. How can the relatively high number of false-positive cases, especially for beginners, be lowered? Which qualitative preconditions have to be fulfilled?
5. What is the influence of hormones or drugs?
6. How can tiny cancers be localized and removed?

In the presence MRM could escalate health costs, if it is applied in an uncontrolled and unselected manner by examiners without experience. Beginners have up to 50% false-positive results causing an initial rise of biopsies. It cannot be imaged that after introduction of screening x-ray mammography all „unclear“ results should be evaluated by MR mammography. Because there is no ultimate definite sign of a benign lesion in X-ray mammography, a huge „wave“ of MR mammography indications must be avoided.
References


Benign breast disease represents a spectrum of disorders that come to clinical attention as imaging abnormalities or as palpable lesions found on physical examination. Following establishment of a benign diagnosis, treatment in general is aimed at symptomatic relief and patient education. Some benign breast diseases, such as atypical hyperplasia, confer an increase in the patient's future risk of developing breast cancer and should lead to counseling about screening recommendations and risk reduction strategies.

This topic will review the pathologic classification and treatment of benign breast disorders. Evaluation of women presenting with symptoms related to the breast and diagnosis of breast disorders are discussed separately. Breast cancer is one of the most common cancers among women worldwide. Ultrasound imaging has been widely used in the detection and diagnosis of breast tumors. However, due to factors such as limited spatial resolution and speckle noise, classification of benign and malignant breast tumors using conventional B-mode ultrasound still remains a challenging task.

H-scan is a new ultrasound technique that images the relative size of acoustic scatterers. In this paper, we proposed a new method based on H-scan ultrasound imaging to classify benign and malignant breast tumors. Backscattered ultrasound radiofrequency signals of 100 breast tumors were used (48 benign and 52 malignant cases). Contrast-enhanced sagittal fat-suppressed breast MR images (flip angle, 10°; echo time, 4.2 msec; repetition time, 7.4 msec) show, A, malignant invasive ductal carcinoma and ductal carcinoma in situ lesion in 48-year-old woman and, B, benign fibroadenoma in 54-year-old woman. C, D. Graphs show contrast-enhanced MR imaging time courses (â—-) for ROIs (yellow on A and B) circumscribing, C, malignant and, D, benign lesions. Faster and greater uptake (followed by washout) compared with a benign lesion such as that of D (â€“). There are two model-fitted curves associated with each lesion data set. Lower dashed curves = best fittings with the standard approach (SA) constrained to the fast-exchange-limit.

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