CHAPTER A21
Breast

INTRODUCTION

Due to the high prevalence, the high mortality, and the operative therapy which is currently required, breast cancer represents a great problem from the medical, psychological, and health policy point of view. In the past 20 years, breast cancer has been the most frequently occurring cancer of women in the western hemisphere. It is the most frequent cause of death of women below 50 years in age and, as a whole, the most frequent cause of cancer mortality of women. Despite the constant improvement of diagnostic procedures, the introduction of novel mammography techniques and ultrasonic methods, in principle, nothing has changed. This dilemma is to be regretted, as the relatively slow growth rates of breast cancer, with tumor doubling times of ∼100 to 300 days, give sufficient time to detect the tumor in a curable stage, i.e., before the formation of external metastases. It is known that a tumor <1 cm in size has an excellent prognosis irrespective of its internal histological structure. It is estimated that a breast cancer needs a period of ∼7 to 10 years for reaching a size of ∼1 cm on an average.

By the introduction of magnetic resonance mammography (MRM), diagnosis of breast cancer has improved significantly. In the early years, there was no agreement as to the value of this method, because of the multitude of different measurement possibilities. The considerably worse spatial resolution compared to X-ray mammography, the inability to detect microcalcifications, the need to use contrast agents, and the high costs of the method were all considered major disadvantages, causing many experienced mammography experts to regard this method with great skepticism; however, after a clinical test phase of ∼17 years, several studies have shown that MRM yields the highest sensitivity in the diagnosis of small breast cancers and that the multifocality/multicentricity of breast cancers can be recognized adequately only with this method.

The utility of contrast media–enhanced MRM can be explained through the generation of early tumor angiogenesis, which probably represents a reliable sign of a breast tumor ≥3 mm in size. To grow uncontrollably, such a tumor needs an increased blood supply for nourishment and removal of metabolic waste materials. Following the injection of a contrast medium, breast cancer exhibits a rapid and often typical quantitative and morphological increase in signal intensity with an early plateau formation or washout effect, whereas the most benign tumors and normal parenchyma usually show a slower and more steady increase in signal intensity.

Meanwhile, there appears to be consensus that for an exact diagnosis of breast cancer, the selection of high spatial *and* temporal resolution in a so-called dynamic technique is of utmost importance. In these dynamic sequences, i.e., the repetitive imaging and measurement of the same slices before and in short time intervals after the injection of contrast medium, the best differentiation between benign and malignant lesions occurs within the first 2 min. Therefore, it is imperative to maintain optimal study conditions. The evaluation of dynamic MRM is simple in some cases but exceptionally delicate in others, and demands a high level of experience on the part of the examiner.

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False positive results can occur due to biological or technical reasons. Biologically false positives can be achieved in the examination of myxoid, fibroadenoma, proliferative displeasures, and acute mastitis; however, most of these cases do not show a plateau phenomenon or wash-out effect, which is the decrease of signal intensity after the initial striking increase observed within the first 2 min. This decrease can be explained by arteriovenous shunts within the tumorangiogenetic network, which induce a sudden washout of contrast medium and therefore a drop in signal intensity. Only a few benign cases in the literature show these so-called wash-out effects. Furthermore, the type of enhancement (centrifugally, centripetally), the presence membranes or septations within in the lesion, as well as the signal-intensity in T_2-weighted scans can be used for the differentiation between malignant and benign enhancing lesions.

Besides false-positive cases due to pathophysiological reasons, there exists an enormous variety of other reasons for different types of enhancement. These include the wrong dosage of contrast medium, the different types of physiological enhancement, and hormone effects. In addition, there exists an enormous variety of technical reasons for various enhancements—for example, wrong coil adjustments, inhomogenous coil adjustments, injection technique, out-of-phase-echo times, and comparison within different MR-sequences without any objective standardization or calibration. The number of false-positive diagnoses due to biological or technical reasons effects the level of specificity. As long as there are no definite standardizations or optimizations, MRM must be considered as a research technique in demand of further development.

False negatives, on the other hand, are fairly rare, and this is meanwhile accepted in a large series of cases revealing levels of sensitivity above 98%. However, different in situ cancers, especially low-grade ductal carcinoma in situ (DCIS) cancers, need not show a tumor angiogenesis and therefore could be left undetected in MRM. Especially for the detection of DCIS, the combined analysis of kinetic and morphological pattern of enhancement (e.g., segmental, unilateral) is important. Other causes for false negatives include rare cases of special lobular cancers and situations after previous bleeding following a core, fine-needle, or open biopsy.

The current approaches to imaging breast cancer using MRM are presented in *UNIT A21.1*, which describes dynamic MRM techniques (multislice 2- and 3-D), as well as fat saturation techniques, which are used mainly in the U.S.

Breast implants are well known to develop problems over time. The ability to detect ruptures is critical to determining the status of the implant. Thus, *UNIT A21.2* describes examination of implants, focusing on the detection of internal or external implant ruptures. Sequences have been developed to focus on the implant and any leakage into surrounding tissue, including fat saturation methods and methods to generally enhance the contrast between the implant (silicon) and surrounding tissue.

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