Current Imaging Diagnosis of the Breast Tumors

Tokiko ENDO

Director of the Department of Radiology, National Nagoya Hospital

Abstract: Breast masses include the tumors or lesions detected by diagnostic imaging as well as those detected by inspection and palpation. In Japan, we make a definite diagnosis, and select appropriate treatment using mammography, ultrasonography, CT or MRI to detect the lesions. Mammography will soon be the leading technique for detecting breast cancer because of the progress that has been made in imaging devices, imaging techniques, and interpretation techniques. Currently, mammography training programs have been launched to popularize the interpretation technique using common technical terms and categorization, imaging techniques, and the techniques for maintaining the precision of devices. Evaluation of the imaging has started to be performed for each institution. Devices for ultrasonography are being improved, and diagnostic criteria are being reviewed. Ultrasonography, which has been used to determine whether lesions are benign or malignant, can be used for suspected diagnosis of breast disease from the aspect of histology, and additional methods for definite diagnosis such as ABC and core needle biopsy are also available. Furthermore, diagnostic imaging of intraductal proliferative lesions and non-invasive breast cancer can be performed without difficulty. Once a patient is diagnosed with breast cancer, she should undergo contrast-enhanced MRM or CT to determine appropriate treatment. The three-dimensional reconstruction image is sufficiently objective to demonstrate the lesion and can be used to obtain informed consent from the patient.

Key words: Mammography; Ultrasonography of the breast; MR mammography; CT mammography

Introduction

In the past, the mammary gland was mainly examined by inspection and palpation and the palpable mass led the patient to consult her doctor. Progress in diagnostic imaging, however, has enabled the visualization of various types of breast lesions such as those detected by inspection and palpation and those only detectable by imaging. The minimization of the
rapidly increasing number of deaths from breast cancer is largely dependent on the development of techniques to discover the abnormality necessarily resulting in tumor.\(^1\) In view of future technological developments, the author will discuss the present conditions of diagnostic imaging of the mammary gland.

Mammography, ultrasonography, MRI, and CT have been widely used in the diagnostic imaging of diseases of the breast. Furthermore, RI has been used to study sentinel lymph nodes. In this paper the current conditions of diagnostic imaging of the breast are described.

### Mammography

The imaging devices and techniques and the interpretation used for mammography are changing considerably. The essential change in mammography is the change in imaging target from the breast to the mammary gland. Conventional mammography covered the nipple and skin, while current mammography covers only mammary gland tissues, which facilitates the detection of abnormalities in the mammary gland. Although the reliability of diagnostic imaging by mammography has been remarkably improved, more clinicians recognize the importance of the maintenance of precision of specifically improved devices.

All the devices used for diagnostic imaging are to meet the mammography guidelines established by the Japan Radiological Society.\(^2\) As a beam receiving system, the screen/film system is required to have high levels of sensitivity and contrast. The observation of the inside of the mammary gland in a small dose can only be achieved when these conditions are satisfied. The films for mammography, which are completely different from the films used in other fields, require strict maintenance of precision in their development.\(^3\)

Compared with conventional standard radiography, which comprises medial-lateral imaging and craniocaudal imaging, the current standard radiography, comprising medial-lateral oblique imaging and craniocaudal imaging visualizes the inside of the breast more extensively. Mammography should not simply be defined as an X-ray examination requiring compression of the breast. Mammography should provide clinicians with sufficient information about the inside of the mammary gland. For this purpose, the mammary glands are to be spread so that overlapp-
ping can be minimized. Only highly-trained and experienced technicians are allowed to perform mammography. The Ministry of Health, Labor and Welfare, which is considering the introduction of mammography into the screening of breast cancer in Japan, is insisting on the importance of device maintenance and the necessity for excellent imaging techniques.

The techniques for interpreting mammograms have been changed and the propositions mentioned in the mammography guidelines have been widely accepted through training seminars. The addition of other findings focusing on the structure of the mammary gland to the conventional mammographic findings of breast cancer, such as tumors and calcification, has been proposed. An interpretation technique for screening has been proposed for the diagnostic process consisting of the definition of individual findings and diagnosis using the definition and the diagnostic tree. This method is widely used in clinical treatment and is regarded as an important property to be shared among all clinicians.

Tumor is classified according to its shape, border, margin, and density (Fig. 1). Calcification is categorized into benign calcification and calcification requiring the differentiation between benignity and malignancy. The latter type of calcification is subcategorized according to shape and distribution (Fig. 2). Regarding other findings, the degrees of benignancy and malignancy are categorized according to the structural irregularity of the lesions (Table 1). In clinical treatment, the results obtained by categorization and those obtained by pathological and histological examinations are used to make a definite diagnosis.

In order to minimize the number of breast cancer deaths, mammography was introduced into the screening of breast cancer. Because appropriate maintenance of devices, accurate interpretation and effective management of the system are indispensable for implementation.
of precision screening, the academic associations which are engaged in screening breast cancer (Japanese Association of Breast Cancer Screening, Japan Breast Cancer Society, Japan Radiological Society, Japanese Society of Radiological Technology, Japan Society of Obstetrics and Gynecology including Japan Association of Obstetricians and Gynecologists for Maternal Protection, Japanese Association of Radiological Physicist) have established a central committee for the assurance of precision in mammography. The central committee organized a subcommittee covering education and training to promote the improvement of imaging and interpretation techniques. The subcommittee sponsored several training programs and its activities have been highly acclaimed. Institutional image evaluation boards have been established and have been conducting their practical activities since April 2001.

With the recent progress in digital technology, new devices for mammography have been developed and improvements made in the techniques of digital mammography. Furthermore, computer assisted diagnostic devices for evaluation of mammograms are also now available. The precision of digital mammography should be as high as that of conventional mammography using screen/film system. The introduction of digital mammography has been welcomed because of its usefulness. This new technique, however, is faced with various problems including image quality and cost-effectiveness. Further improvement of digital mammography is eagerly anticipated ahead of its practical introduction.

**Ultrasonography**

The devices for ultrasonography have been improved and remarkable advances made in diagnostic imaging by means of ultrasound. In addition to the information provided by brightness-mode (B-mode) images, blood flow information obtained by color Doppler method is used for diagnostic imaging. The high-frequency probe for surface organ is indispensable in the examination of breast disease. Diagnosis of the breast disease can not be made by the expanded application of the abdominal probe.

The Diagnostic Criteria for Breast Lesions, which was established by the Japan Society of Ultrasonics in Medicine in 1987, has contributed toward differentiating the mass lesion between benign and malignant. In recent years, ultrasonography has been indicated for the diagnosis of histological type, diagnosis of intraductal spreading of the lesion and diagnosis of non-mass forming lesions. In order to deal with the recent conditions, the Japan Society of Ultrasonics in Medicine organized a subcommittee to promote the establishment of the diagnostic criteria of diseases of the mammary gland as a part of the committee for establishing a glossary and diagnostic criteria. This subcommittee is reviewing the current situation in order to establish a diagnostic criteria which can satisfy clinical needs. The draft of the diagnostic criteria is stated for presentation within 2001 and its practical introduction is expected.

Histological type is determined by evaluating the shape, echo pattern of the border, internal echo pattern, and degree of ultrasonic attenuation (by posterior echo intensity) and identifying the constitutive tissues or substances of the tumor. Ultrasonic attenuation is less remarkable within moist cysts, mucus, and cell components, and posterior echo is enhanced in extreme cases. Ultrasonic attenuation associated with a acoustic shadow is recognized within the fibrous tissues of scirrhous carcinoma. Generally, the combination of these echo patterns is observed in tumors and histological diagnosis can therefore be made by interpreting the details of each echo pattern. Echograms provide reliable information which can not be obtained by mammography.

Additional information such as blood flow information provided by the color Doppler method and contrast ultrasonography other than B-mode imaging has contributed to improvements in the accuracy of histological diagnosis.
These new techniques are gradually being introduced into clinical treatment.

The success of breast-conserving treatment depends on the imaging diagnosis of the intraductal components of the breast cancer. Recently developed devices can visualize the minimum dilatation of the duct and tumor and/or microcalcification in the duct. Such technological progress enables visualization and identification of the cancerous components in the duct and non-mass forming breast cancer (Fig. 3). Ultrasonography provides new simple approaches to cytology or core biopsy of disease of the mammary gland which forms no palpable tumors and accordingly plays an important role in the examination of the mammary gland.

**MRI and CT**

Currently breast-conserving surgery is adopted as a routine surgical treatment for breast cancer. The cancerous lesion should be accurately, clearly, and stereoscopically visualized so that the lesion can be thoroughly resected. For this purpose, MRI and CT have been introduced into practical treatment as the most effective examinations.

The machines used for MRI and CT are expensive diagnostic apparatus. When we examine the breast by MRI, we have to prepare a phased-array coil for the breast. Considering the time necessary for examination by means of nuclear magnetic resonance, its introduction into routine screening is not recommended. Generally, MRI is indicated for patients who have already been diagnosed with breast cancer, and includes those women who are to undergo breast conserving surgery or those whose requests for breast-conserving surgery are likely to be rejected. MRI is used in these cases only to clarify the affected area. As an exception, screening by MRI is indicated for patients who have received an implant insertion because examinations other than MRI are usually ineffective in these cases. In Japan, implant insertion is not common. MRI will be widely introduced into screening tests for detection of local recurrence and metachronal multiple lesions as a result of the popularization of breast-conserving treatment and breast reconstruction surgery.

In MRI, a contrast medium is used to conduct dynamic studies and differentiation between benignancy and malignancy is made according to the chronological and spatial imaging patterns. Furthermore, the diagnostic imaging of the spread of malignant lesions is also performed. Although the type of manipulation varies according to the apparatus used for MRI, an example is given below by way of explaining the practical technique.

A scan is conducted prior to imaging. Contrast medium (Gd-DTPA 0.1 mm Mol/kg) is injected intravenously and scans are performed repeatedly 2, 4, and 8 minutes after intravenous injection. Generally, the malignant lesion is stained in the early scan image and ring enhancement is characteristic of serious degeneration including scirrhouss carcinoma. Blush in a benign lesion is gradually enhanced and the inside of the lesion is stained in a relatively uniform manner. The septal wall of fibroadenoma is occasionally visualized. The lesion within the lactiferous duct is visualized as a funicular struc-
Fig 4  Diagnostic imaging of the spread of breast cancer by MRI
All the lobes affected by the extended non-infiltrating cancer are clearly stained.

ture starting from the primary tumor, while multiple lesions are visualized as nodules, which are separate from the primary tumor (Fig. 4). Depending on the histological subtypes of the components within the lactiferous duct, relatively small malignant lesions are not necessarily visualized. MRI is not always effective for making a differential diagnosis of mastopathy.

The theory of three-dimensional visual information obtained by MRI can be directly applied to CT. The effectiveness and usefulness of MRI are virtually identical to those of CT.11) Compared with MRI, CT is less expensive and more widely used in clinical treatment, as it can be completed within a short period of time. Some surgeons may request the implementation of breast-conserving treatment although hospitals are not equipped with the apparatus to perform MRI. In these cases, the introduction of CT is recommended because CT can provide similar information to that supplied by MRI. Thanks to the recent development of multidetector-Row CT (MD-CT), we can obtain more accurate and detailed three-dimensional images.

Below is an example of a currently adopted technique. Nonionizing contrast medium (90 ml) is injected at the rate of 1.5 ml/sec. Seventy to 100 seconds later, an area ranging in size from 9 to 11 cm is scanned while the patient holds her breath under the following conditions: beam amplitude 3 mm and table rate 3 mm/0.8–1 sec. Image reconstruction is conducted at intervals of 1.5 mm to display the three-dimensional image of the lesion. (The rate of injection of contrast medium and the time required for scanning are individually determined by the facility performing the technique. They are also affected by the types of apparatus used for CT scan.)

In the images obtained by these techniques, the spread of disease is stereoscopically visualized and multiple lesions or disseminated lesions are clearly detected without difficulty. Because these techniques provide surgeons and patients with convincing visual information, the images can be used to explain the pathological conditions to the patients and to obtain their informed consent for surgery.

Conclusion

This paper explains the current conditions of diagnostic imaging for detection of disease of the mammary gland including mammography, ultrasonography, MRI, and CT. Diagnostic imaging is useful for detecting both palpable tumors and non-mass forming lesions. It is used to determine the appropriateness of breast conserving treatment and is applied to various examinations including screening, cytology, and biopsy for detection of non-palpable non-mass forming lesions.

REFERENCES

2) Japan Radiological Society, Japanese Society of Radiological Technology, ed.: Mammo-


