NOTE

Dual Enhancement MR Mammography for Intraductal Breast Carcinoma: Intraductal and Intravenous Administration of Contrast Media (Gd-DTPA)

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MR mammography with combined enhancement of intraductal and intravenous administration of gadopentetate dimeglumine was performed in three patients with nipple discharge. MR images with intraductally administered contrast media (MR galactography) revealed obstruction or irregularly narrowing of the duct. Bolus, intravenous enhanced images demonstrate the relation between ducts and tumor and allowed differentiation of malignant lesions from benign ones.

INTRODUCTION

Recently, breast-preserving surgery for early breast carcinoma has become preferable to radical mastectomy, and to perform this procedure, precise evaluation of the intragland extension of the tumor is mandatory[1),2)]. The usefulness of conventional X-ray galactography remains controversial; while several surgeons consider it unreliable in differentiating carcinomas from papillomas, others find it useful as a 'road map' demonstrating the location and extent of the tumor[3)~6)].

Contrast enhanced magnetic resonance (MR) imaging has frequently been performed to evaluate breast tumors. Some investigators have reported that dynamic turbo-fast low-angle shot (FLASH : Siemens, Erlangen, Germany) is an optimal sequence for differentiating malignancies from benign lesions[7)~9)]. We performed intravenously enhanced MR mammography combined with MR galactography injecting Gd-DTPA into the mammary ducts of patients with nipple discharge. This intraductal

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and intravenous dual-enhanced MR mammography accurately demonstrates the relation between ducts and tumors, and provides a time-intensity curve for tumors that can be useful in differentiating malignancies from benign lesions. To our knowledge, there is only one prior literature describing MR galactography[10], but MR galactography with dynamic study has not been reported previously.

MATERIALS AND METHODS

Three female patients (42–74 year old) with spontaneous unilateral nipple discharge underwent dual enhancement MR mammography after informed consent was obtained.

After IV line with 24-gauge needle was placed in the antecubital vein, a straight 24-gauge blunt catheter needle was inserted several millimeters into the discharging mammary duct and contrast material was injected. Needle insertion and contrast injection must be gentle to avoid extravasation. The contrast media was composed of 0.3–0.5 ml of gadopentetate dimeglumine (Gd-DTPA; Magnevist, Schering AG, Berlin, Germany) diluted into 20 ml of saline[10]. The contrast injection was terminated when the patient felt fullness or discomfort in the breast, or when reflux of contrast material was observed. The amount of contrast medium required ranged from 0.5–1.0 ml. Then the nipple was gently tied with thread to prevent leakage of contrast medium.

The patient was placed prone in the MR imager suspending the breasts into a bilateral breast coil. Breast MR images were obtained with a 1.0 T imager (Magnetom Expert; Siemens Medical Systems, Erlangen, Germany), with bilateral breast coil. First, sagittal T_1-weighted spin echo images with fat suppression were obtained from the diseased breast (repetition time [TR] 600 ms, echo time [TE] 12 ms, single acquisition, 4 mm slice with 2 mm gap, field of view [FOV] 14×16 cm, matrix 224×256). Then three dimensional [3D] bilateral T_1-weighted images of bilateral breasts were obtained using FLASH sequence with fat suppression (TR 47 ms, TE 10 ms, flip angle 40, 1.5 mm slice gapless, FOV 26 cm, matrix 192×256).

Selecting 3 slices that demonstrated ductal abnormality such as narrowing, apparent distortion, filling defects or irregular wall, dynamic MR scan was carried out with manual intravenous injection of Gd-DTPA (0.1 mmol/kg of body weight). These dynamic images were obtained using a sagittal T_1-weighted FLASH sequence (TR 51 ms, TE 5 ms, flip angle 90, 4 mm slice, 2 mm gap). Then sagittal T_1-weighted spin echo imaging and 3D FLASH imaging of the whole breast were obtained.

Time intensity curves of the lesions were provided from dynamic study and 3D image of the entire breast with maximum intensity projection [MIP] method were obtained to evaluate the relation between abnormal ducts and the lesions.

CASE REPORT

Case 1. A 42-year-old female complained of left nipple discharge without palpable mass. Mammogram demonstrated calcified foci in the left breast but there was no tumor detected.

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Most calcified foci showed poorly defined margins although one focus was well demarcated. US failed to demonstrate any abnormality. On conventional galactogram, an abnormal duct showed obstruction 2.6 cm from the nipple and wall irregularity was noted approximately 2–2.6 cm from the nipple (Fig. 1a). MR galactogram demonstrated the duct 7.0 cm from the nipple. Further MR galactogram revealed a defect extending from 2.5 to 4.7 cm with distal ductal dilatation extending from 4.7 to 7 cm. On MR scan with intravenous contrast material, the defect of the duct showed remarkable early enhancement. The 3D image of MR galactogram with MIP method before and after administration of intravenous contrast material (Fig. 1b, c) provided relation between the duct and the tumor. The sagittal T_1-weighted spin echo images with fat suppression before and after administration of intravenous contrast material (Fig. 1d, e) demonstrated more clearly about the tumorous bound. The dynamic MR scan with intravenous contrast medium was performed and the time-intensity curve of the lesion demonstrated a steep slope that indicating malignancy (Fig. 1f). Microdochectomy demonstrated non-invasive intraductal carcinoma with diffuse intraductal spread.

Case 2. The patient was a 46-year-old female with left nipple discharge. She had a palpable mass in the left breast diagnosed as intraductal papillary tumor 2 years earlier. US revealed a tumor measuring 8 mm in diameter. The duct was visualized 4.3 cm from the nipple and an intraductal filling defect was found 1.9 cm from the nipple on conventional X-ray galactogram. MR galactogram demonstrated the duct 4.0 cm from the nipple and the dilated duct 1.8 cm with apparent obstruction. On MR scan with intravenous contrast material, the defect of the duct showed early enhancement, but the margin was poorly defined. On dynamic study, the time-intensity curve obtained at the abnormal duct demonstrated a relatively steep slope although the slope was gentler than that in case 1 and did not necessarily indicate malignancy (Fig. 2). On microdochectomy, the lesion proved to be intraductal papilloma histologically.

Case 3. The patient was a 74-year-old female with bloody discharge from the right nipple, however there was no palpable tumor. Mammogram demonstrated small calcified foci, but there was no mass lesion detected. There were no abnormalities found on ultrasonography. Conventional X-ray galactogram revealed extended distribution of the mammary duct that measured 7.2 cm from the nipple and ductal dilatation was noted 1.7 cm from the nipple. On MR galactogram, this dilatation was again demonstrated and, further, proximal narrowing and wall irregularity were also demonstrated. Then, intravenously enhanced MR mammography demonstrated an enhanced lesion around the narrowed proximal duct. Dynamic study was not performed. Microdochectomy was carried out and intraductal carcinoma (ductal carcinoma in situ) associated with intraductal hyperplasia was confirmed pathologically.

DISCUSSION

Most non-palpable intraductal neoplasms of the breasts do not present any abnormal findings on mammograms or ultrasonograms. Galactography has been recognized as useful to identify and localize abnormalities in patients with nipple discharge. Although surgeons who perform mastectomy or major dochectomy on

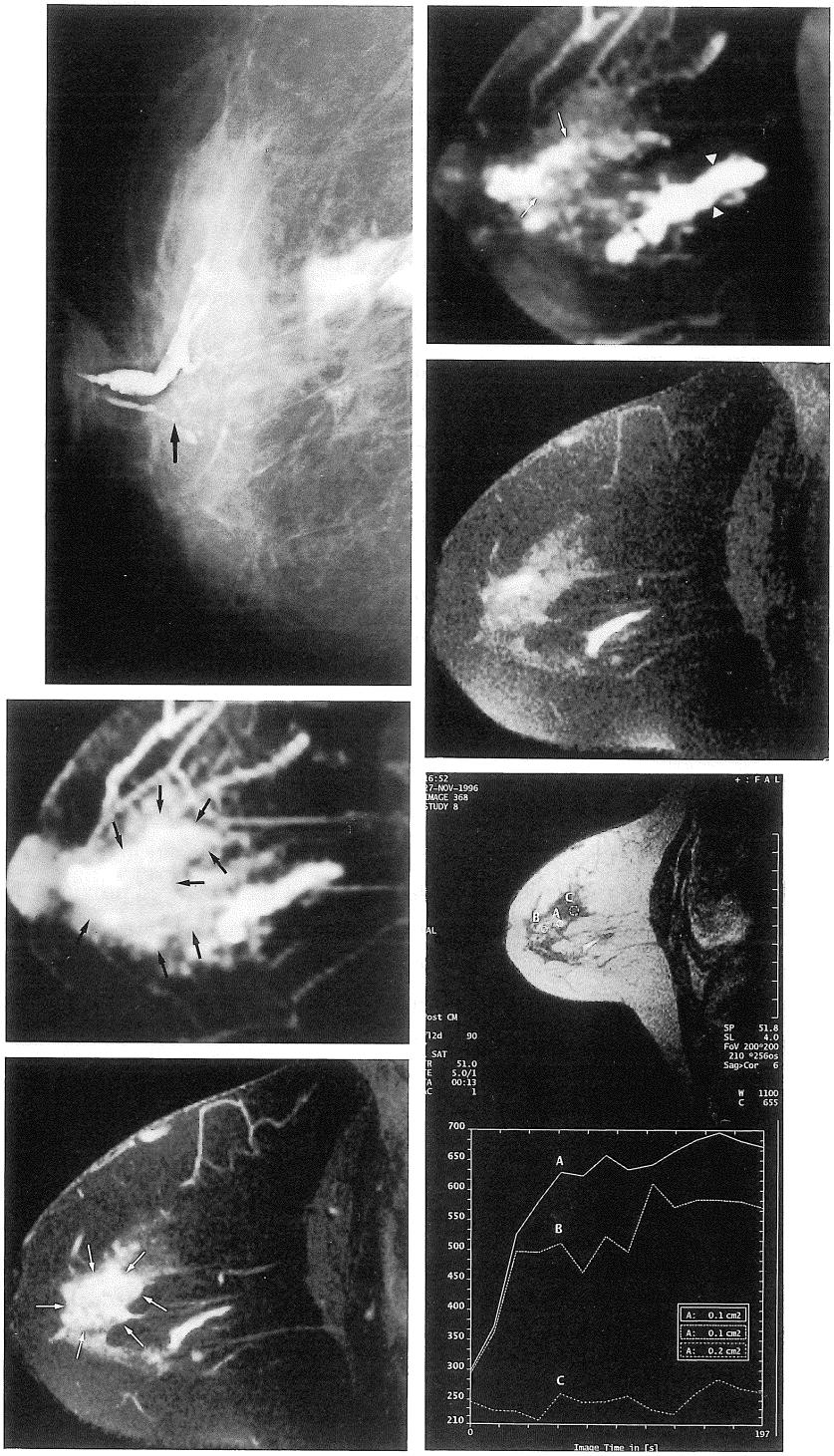

Fig. 1.

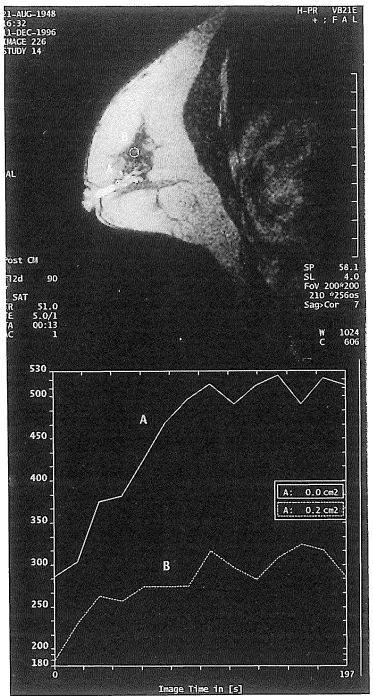

Fig. 2. Images from a 46-year-old woman with left nipple discharge (Case 2). The tumor was intraductal papilloma.
Time-intensity curve obtained at the defect of the duct demonstrated a relatively steep slope (Same sequence as Fig. 1f).

such discharging breasts scarcely admit the usefulness of galactography, the modality is indispensable to surgeons who perform less radical surgery or microdochectomy.

In this study, conventional X-ray galactography visualized 2.6–7.2 cm of the length of the ducts from the nipple. MR galactography visualized 4.2–5.8 cm on spin-echo T_1-weighted images, and 4.0–7.0 cm on 3D T_1-weighted FLASH images. On spatial resolution, MR galactogram can not match conventional X-ray galactogram. Spatial resolution of 3D images is 1–2 mm while that of spin echo T_1-weighted image is 0.6 mm. However, abnormal findings of mammary ducts, such as ductal narrowing, distortion, filling defects and wall irregularity, were equally obtainable and accurate by both conventional and MR galactography.

Although the detectability of intraductal abnormality on MR galactography is the same as that of conventional X-ray galactography, MR galactography has several advantages compared with that of conventional galactography. While conventional galactography provides, essentially, 2 views : cranio-caudal and mediolateral from which the observer must create his

Fig. 1. Images from a 42-year-old woman with left nipple discharge (Case 1). The tumor was non-invasive intraductal carcinoma with diffuse intraductal spread.
(a) Conventional X-ray galactogram on mediolateral view showed irregularity and apparent obstruction of the duct (arrow).
(b) The 3D images of MR galactogram with MIP method before administration of intravenous contrast material revealed severe stenosis with wall irregularity (arrow) and dilatation of the distal and proximal ducts (arrow hed). (T_1-weighted image using FLASH, with fat supression, TR 47 ms/TE 10 ms, flip angle 40, 1.5 mm slice gapless, FOV 26 cm, matrix 192×256).
(c) The 3D images of MR galactogram with MIP method after injection of intravenous contrast media showed an enhanced mass (arrow) measuring 2.5 cm at the stenotic duct (Same sequence as Fig. 1b).
(d, e) The sagittal T_1-weighted spin echo images with fat suppression before and after administration of intravenous contrast material demonstrated more clearly about the tumorous bound (arrow). (T_1-weighted spin echo image, with fat supression, TR 600 ms/TE 12 ms, single acquisition, 4 mm slice with 2 mm gap, FOV 14×16 cm, matrix 224×256).
(f) Time-intensity curve obtained at the defect of the duct demonstrated a markedly steep slope. (T_1-weighted image using FLASH, TR 51 ms/TE 5 ms, flip angle 90, 4 mm slice, 2 mm gap, FOV 20 cm, matrix 210×256).

own image of the abnormality, with high spatial 3D rotating delivery of excitation off resonance (RODEO), MR galactography provides a more accurate image of duct abnormality. On MR galactography administration of contrast medium requires less pressure than conventional galactography because of low viscosity. MR galactography does not need compression of the breasts as in conventional galactography. Therefore, patients experience less discomfort during MR galactography.

As indicated above, the detectability of intraductal abnormality on MR galactography is the same as that on conventional X-ray galactography. However, with intravenous administration of contrast material, MRI provides additional information regarding the mass. Whereas time-intensity curves of breast tumors on dynamic study are still somewhat controversial, many surgeons consider it helpful in differentiating malignancies from benign lesions. However, performing dynamic contrast-enhanced MRI of very small, almost undetectable tumors is not easy and intraductal tumors are examples of such difficult-to-detect tumors. With the help of MR galactography, we can easily determine where to focus the study using dynamic contrast scan.

We were able to preoperatively diagnose case 1 as malignant tumor, however we could not comfirm that case 2 involved intraductal papilloma. Because there are few case reports describing dynamic study of non-palpable lesions such as intraductal papilloma. The characteristic dynamic pattern of intraductal papilloma has not been established. In such cases MR galactography would be useful for navigator of dynamic study. Further, with this dual enhanced MR mammography, we can obtain crucial information for treatment, such as the relationship between the tumor and ducts, extent of tumors, and presence of extraductal invasion.

CONCLUSION

Though this study consisted of a very small group, and despite the limitation of spatial resolution and signal-to-noise ratio on MRI, we consider this dual enhanced MR mammography superior to the existing methods of evaluating breasts with nipple discharge with or without palpable mass.

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