Pictorial Essay

Nonconventional Options for Tumor Localization in Breast and Axillary Lymph Nodes: A Pictorial How-To

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Abstract

Preoperative localization of breast malignancies using traditional ultrasound and digital techniques can be challenging, particularly after neoadjuvant chemotherapy when the target is not conspicuous. The purpose of this paper is to pictorially present nontraditional techniques that have been helpful in preoperative localization before surgery. We will discuss techniques for breast lesion localization using computed tomography (CT) and magnetic resonance imaging (MRI) as well as axillary lymph node localization using tomosynthesis, CT, and MRI.

Keywords: *Computed tomography, localization, magnetic resonance imaging, tomosynthesis*

Introduction

Malignancy in the breast or metastatic lymph nodes (LNs) is commonly localized before surgery to assist the surgeon in locating the site of disease for operative removal.[1,2] Ultrasound guidance is generally the preferred method to localize malignancy in the breast or to localize metastatic axillary lymphadenopathy when the target is visible sonographically. Like biopsies, an ultrasound-guided localization is more comfortable for the patient as the breast is not in compression during this procedure. A digital localization technique is also commonly used for localization of lesions in the breast when the tumor is not well-visualized sonographically. In such cases, the clip marking the site of disease is mammographically visible for digital localization before surgery. However, not infrequently, preoperative localization of the tumor and/or the clip marking the site of disease cannot be performed, especially after neoadjuvant therapy (NAT), using the above-mentioned traditional ultrasound or digital methods. The purpose of this paper is to describe nontraditional methods for localization of tumor within the breast or axillary LNs in difficult cases when traditional techniques fail. The techniques presented are based on well-established cross-sectional (computed tomography [CT] and magnetic resonance imaging [MRI]) interventional methods.[3-9] The translation of these techniques to breast interventional techniques is highlighted here.

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Computed tomography guidance

CT guidance for localization in the axilla is an option if the clip is not visible on ultrasound or mammogram. Axillary clips can sometimes be difficult to visualize on ultrasound, especially if the LN has normalized in size after NAT. LNs situated high in the axilla also may not be included in the field of view on digital mammogram. In such cases, a limited noncontrast CT of the axillary region can be obtained with the patient in the supine position. Most clips are visualized on CT as metallic artifact, making it easy to identify the clip within a normal size metastatic LN seen after NAT on CT. Once the metastatic LN is identified, it can be localized using CT fluoroscopy, and a seed or wire can be deployed within the metastatic LN as demonstrated in Figure 1a-f. The method is similar to CT-guided seed localization in the breast as illustrated in Figure 2a-e.

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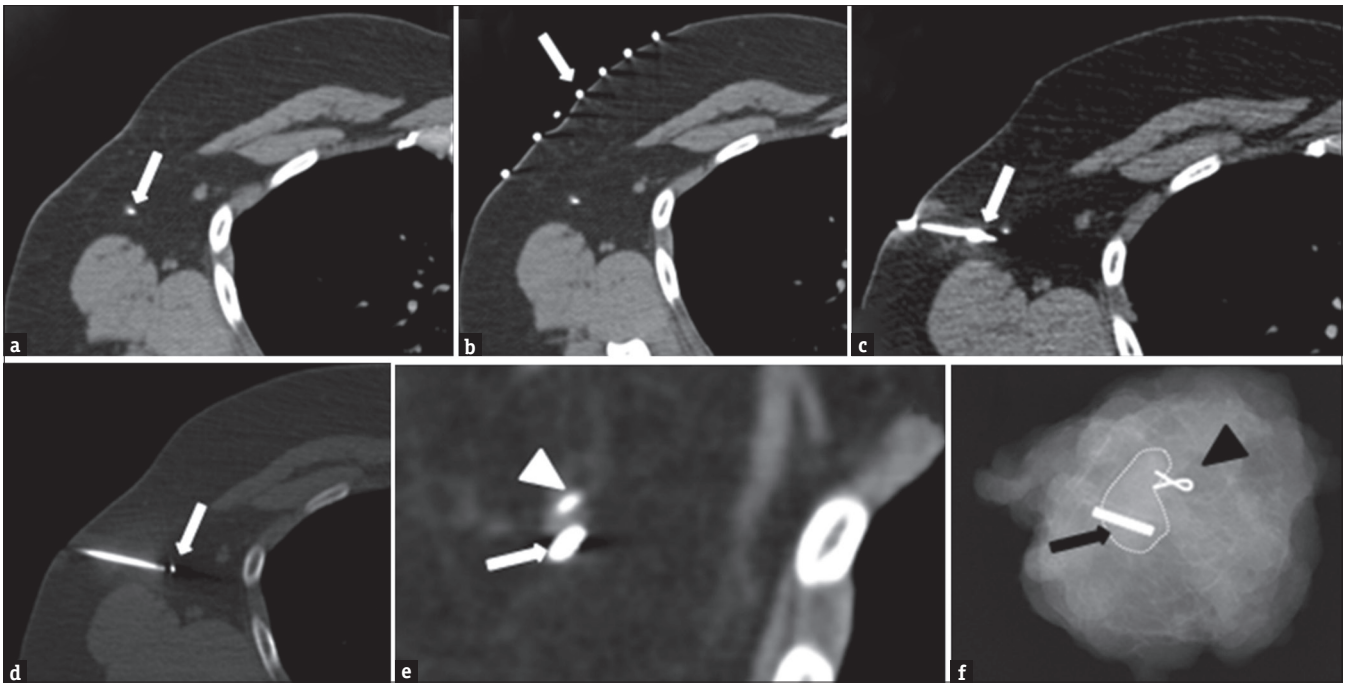

Figure 1: A 56-year-old female with biopsy-proven metastatic right axillary lymphadenopathy which became sonographically occult after neoadjuvant chemotherapy. Its far superior and posterior location, approximately 18 cm from the nipple, made localization by digital mammographic techniques difficult, so seed localization was performed under computed tomography guidance. (a) Preprocedural axial computed tomography identifies the targeted clip (arrow). (b) Repeat computed tomography with overlying opaque fiduciary markers (arrow) in place to help guide needle placement along the correct trajectory toward the clip. (c) An 18-gauge coaxial preloaded seed needle system (Best® Medical International, Springfield, VA, USA) (arrow) is advanced toward the clip for localization. It is slightly posterior to the target. (d) Needle is redirected towards the clip and is now seen immediately superficial to the clip (arrow). A I-125 radioactive seed was subsequently deployed. (e) Coronal image demonstrates the seed (arrow) to be immediately inferior to the clip (arrowhead), abutting the targeted lymph node. (f) Specimen radiograph from lumpectomy specimen demonstrates a faint outline of a lymph node with a targeted clip (arrowhead) and seed (arrow) within the excised tissue.

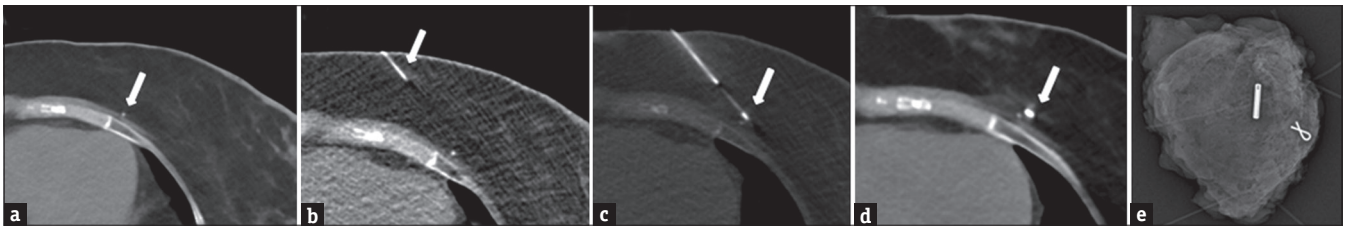

Figure 2: 57-year-old female with biopsy proven invasive ductal carcinoma in the lower outer left breast with a biopsy proven metastatic intramammary lymph node marked with a ribbon clip. Both the lymph node and the clip were sonographically occult after 5 months of neoadjuvant therapy. (a) Initial computed tomography axial slice identifies the radiodense clip in the far posterior left metastatic intramammary lymph node (arrow) which itself is no longer visible on computed tomography. (b) Axial computed tomography shows a 25-gauge local anesthesia needle confirming the trajectory for needle-directed seed localization. (c) Axial computed tomography confirms the 18-gauge coaxial localization needle tip (arrow) immediately adjacent to the clip, and a single radioactive I-125 seed is deployed. (d) Axial computed tomography after seed deployment confirms the seed (arrow) positioned immediately adjacent to the biopsy clip marking the site of malignancy. (e) Specimen radiograph from lumpectomy shows successful resection of both the radioactive seed and the ribbon shaped clip.

Magnetic resonance imaging guidance

MRI guidance for clip placement or localization is much less frequent, and it is usually considered when the initial target was only visualized by MRI.[10,11] For MRI-guided approaches, the patient is scanned in the conventional prone position similar to MRI breast biopsies. Intravenous gadolinium-based contrast agent may or may not be needed to locate the target lesion in the breast.

Clip placement and localization in the breast under magnetic resonance imaging guidance

There are times when the lesion/clip cannot be visualized by ultrasound, and the clip cannot be localized using a digital technique due to clip migration after biopsy. When the initial target is only visualized with MRI, MRI-guided clip placement may be utilized for accurate localization for subsequent digital localization at a different time. For MRI-guided clip placement and

localization, the patient is placed in a prone position with the breast compressed, similar to performing a breast biopsy. A noncontrast sequence is initially performed to localize the region of tumor. Once the appropriate region of interest is in the field of view, contrast is administered to identify the tumor, and clip placement which can then subsequently be localized with digital mammogram technique. An MRI-guided clip placement is illustrated in Figure 3a-e.

Localization under MRI guidance can be performed using a radioactive seed or a wire, as illustrated in Figure 4a-d. A bracketed seed or wire may also be placed under MRI guidance to localize a large area of enhancement which may not have a mammographic or sonographic correlate, as illustrated in Figures 5a-f and 6a-d, respectively.[10,12]

Caveat for all magnetic resonance imaging-guided seed localization procedures

The preparation for MRI-guided I-125 seed localization must take into consideration the rare possibility of dropping a seed in MRI Zone 3 or Zone 4 where current Geiger counters are inadmissible.[13] Until MRI-safe Geiger counters are available, prevention of dropping the seed is of utmost importance. When such a procedure is necessary, we employ a minimum of four people who are assigned the sole task of verifying visual confirmation of where the seed is at any time. From the time, the seed is handled from Zone 3 to Zone 4;

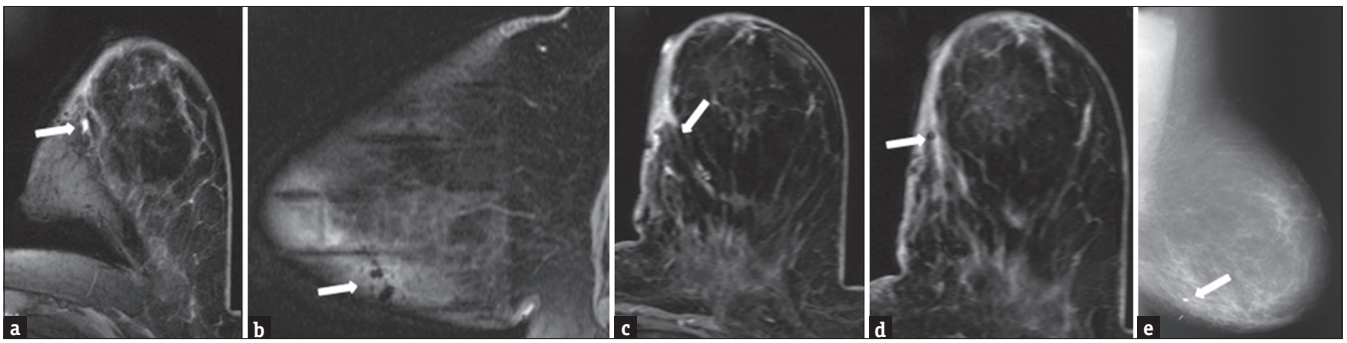

Figure 3: 55-year-old with left bloody nipple discharge status postductal excision which revealed a 1 cm noninvasive papillary carcinoma with positive margins. Postoperative MRI demonstrated a suspicious 5 mm focus of enhancement close to the excision site which needed to be included in the surgical re-excision. Due to small size of lesion, and lack of correlate on mammogram and ultrasound, an magnetic resonance imaging guided clip placement was performed. (a) Postcontrast axial sequence from the postoperative diagnostic breast magnetic resonance imaging demonstrating a suspicious 5 mm focus of enhancement (arrow) close to the excision site in the medial inferior left breast. (b) Sagittal image from the precontrast sequence demonstrates the grid to be well positioned with the postsurgical region (arrow) included in the field of view and within the grid. (c) Axial postcontrast sequence with a medial grid in place demonstrates the enhancing mass (arrow) abutting the skin to be well positioned within the grid. The mass appears closer to the skin compared to the diagnostic magnetic resonance imaging due to compression from the medial grid. (d) Postprocedure magnetic resonance imaging demonstrating the clip (arrow) to be well positioned within the enhancing mass. (e) The clip was subsequently localized with a radioactive seed using a digital technique. Postlocalization mammogram demonstrating the seed to be in close proximity to the biopsy clip.

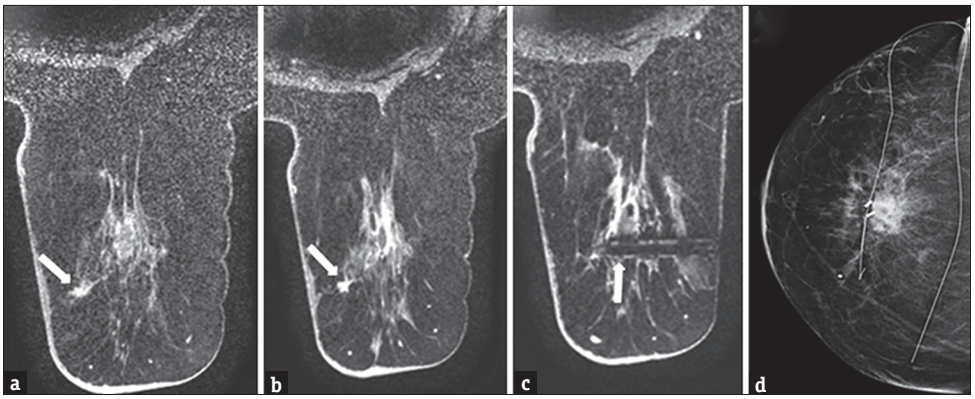

Figure 4: 76-year-old female with history of right breast invasive ductal carcinoma status postlumpectomy. Follow up magnetic resonance imaging 1 month later demonstrated a 7 mm mass at site of prior lumpectomy which was not visualized sonographically but was considered suspicious for residual malignancy. A magnetic resonance imaging guided wire localization was therefore performed and patient went for surgical removal. (a) Precontrast biopsy images demonstrating the suspicious mass in the medial breast (arrow). A grid is noted on the skin laterally. The mass is well positioned in the region of the grid. (b) Postcontrast magnetic resonance axial image for localization purposes demonstrating the enhancing mass (arrow). The mass is well visualized for localization. (c) Axial image demonstrates a needle tip placed immediately adjacent to the enhancing mass (arrow). A wire was subsequently deployed in this region. (d) Postplacement CC mammogram demonstrates the superficial to mid aspect of the thickened segment of the localization wire along the anterior edge of the abnormality.

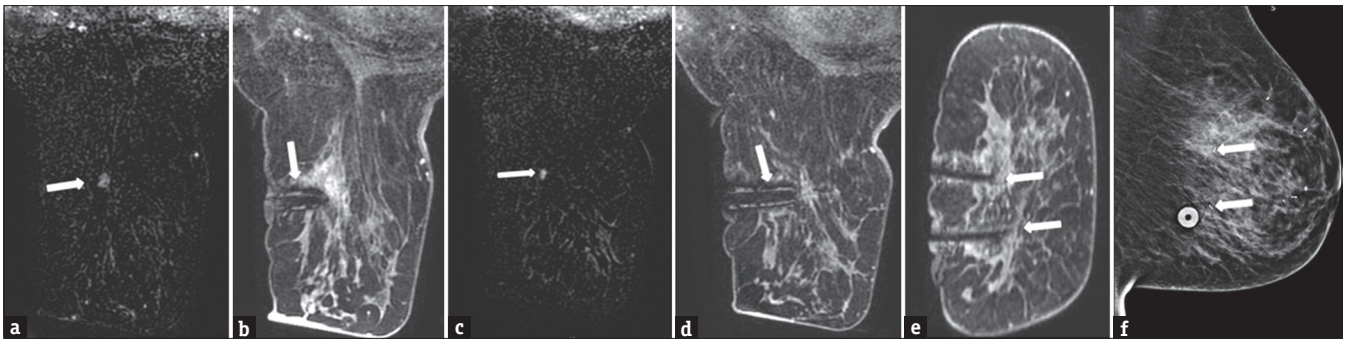

Figure 5: 70-year-old female with newly diagnosed invasive lobular carcinoma of the left breast. Staging magnetic resonance imaging demonstrated 2 similar-appearing small enhancing masses anterior to the biopsy-proven malignancy. The lesion farthest away was biopsied under magnetic resonance imaging with benign results. It was decided that the 2nd lesion that was closer to the biopsy proven malignancy should be localized for surgery. A two site magnetic resonance imaging guided radioactive seed localization was performed. (a) Axial postcontrast subtraction images demonstrating an enhancing mass (arrow) representing the biopsy proven malignancy. (b) This mass was localized using the nonsubtracted images to better visualize placement of the localization device (arrow). (c) A 2nd suspicious lesion (arrow), 3 cm inferior and slightly anterior to the index malignancy is seen on subtraction images on day of biopsy. (d) The nonsubtraction images were used for the procedure to visualize the localization device (arrow). (e) Coronal postcontrast image with one obturator in the superior mass and one in the inferior mass. Both obturators are in good position (arrows). A radioactive seed was subsequently deployed through each biopsy system. (f) Postprocedure mammogram demonstrating both radioactive seeds in good position (arrows).

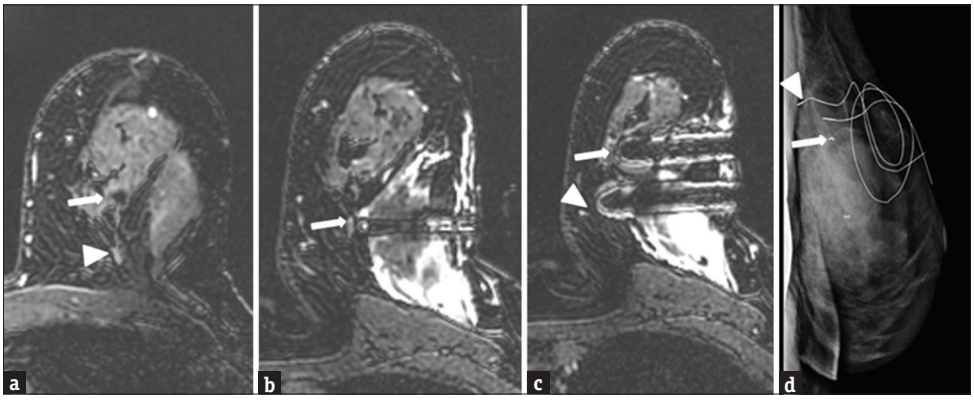

Figure 6: 52 year old female with biopsy proven left breast invasive ductal carcinoma, marked by a wing shaped clip. Postneoadjuvant therapy magnetic resonance imaging demonstrated an additional focus of enhancement 1.3 cm posterior to the index mass which was suspicious. Magnetic resonance imaging guided two-site wire localization of a known breast malignancy associated with a wing-shaped clip and of an adjacent suspicious focus was performed. (a) Noncontrast sequence at the time of Magnetic resonance imaging guided biopsy demonstrating susceptibility artifact from clip marking the site of biopsy proven malignancy (arrow). The suspicious focus of enhancement is seen posteriorly (arrowhead). A grid is present laterally as noted by flattening of the skin, but is not well visualized on this image. (b) Postcontrast image postplacement of the biopsy device in good position and obturator in place from a lateral approach. The suspicious focus of enhancement (arrow) is noted immediately medial to the tip of the obturator. (c) A 2nd biopsy device is positioned anteriorly (arrow) in the region of biopsy clip marking the site of malignancy. The biopsy clip is immediately inferior to the obturator tip. Arrowhead marks obturator placed at the suspicious focus of enhancement. (d) Postprocedure mammogram demonstrating the posterior wire in good position (arrowhead), immediately posterior to the region of enhancement noted on magnetic resonance imaging. Given that this focus is mammographically occult, postwire localization magnetic resonance imaging suggests that it should be near the distal thickened hook portion of the wire. The wing clip (arrow) marking the site of biopsy proven malignancy is approximately 1 cm inferior to the hook portion of the anterior wire. Ribbon clip in the inferior breast is from a prior benign biopsy.

the radiologist announces where the seed is and waits for verification by all the assigned observers. Before the procedure, the procedural area including a larger work area is draped, paying close attention to cover any small gaps between equipment interfaces. Whenever possible, white draping is selected.

Digital tomosynthesis

Tomosynthesis-guided procedures can be approached in much the same way as CT-guided procedures. As such, the direction of approach can be orthogonal (through an opening in the compression plate), in-plane (free handed between the detector and the compression plate, or with a lateral arm), or oblique (free handed usually between the detector and the compression plate). We show a digital tomosynthesis approach to localize a sonographically occult positive axillary LN in Figures 7a-e and 8a-c. Because the seed is often placed in the same direction as the direction of compression, we have found that there is a tendency for the seed to sometimes migrate when compression is released. To lessen this "accordion effect," we occasionally release some compression (~5–10 Newtons) just before seed placement to

determine if the seed should be deployed. Alternatively, we sometimes place the seed needle perpendicular to the direction of compression, or if placed in the direction of compression, we acquire another view in-plane with the needle (just as in a digital non-tomosynthesis technique) before deployment of the seed.

Ultrasound localization using iodinated contrast

In cases where a possible clipped metastatic LN is identified on ultrasound, but is not definitive, either because the LN has decreased in size post-NAT or due to nonvisualization of clip, a small amount (approximately 1–1.5 cc) of 1:10 dilution iodinated contrast (e.g., Omnipaque 350) may be injected into the suspected LN using sonographic guidance, and a mediolateral (ML) or ML oblique view mammogram may be obtained. This will confirm if the suspected LN identified on ultrasound is indeed the clipped node as it will contain radiopaque contrast material. The patient can then be returned to ultrasound, and the node may be localized with sonographic guidance. This technique is illustrated in Figure 9a-g.

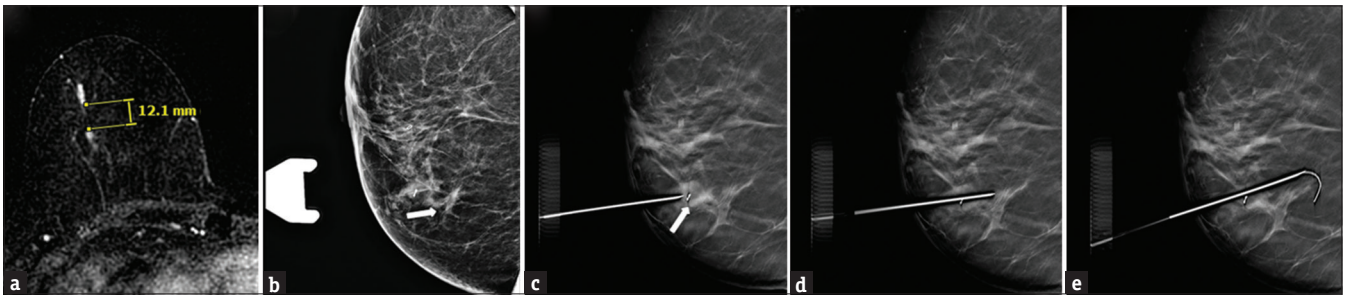

Figure 7: 70-year-old female with a history of right breast atypical lobular hyperplasia and multiple other benign biopsies. High risk screening magnetic resonance imaging, demonstrated a new suspicious linear nonmass enhancement which underwent MR biopsy and demonstrated ductal carcinoma *in situ*, marked by a bowtie-shaped clip. There was an additional enhancing mass seen on magnetic resonance imaging 1 cm posteriorly that in retrospect correlated with a mammographic focal asymmetry. The surgeon requested a single wire localization of both the clipped malignancy as well as the nearby focal asymmetry. (a) Initial magnetic resonance imaging demonstrates suspicious linear nonmass enhancement in the lower outer breast, middle dept. (b) Initial mediolateral scout image prior to tomosynthesis guided localization demonstrating a focal asymmetry (arrow) in the inferior breast. (c) Tomosynthesis image demonstrates the needle tip and targeted bow-tie clip (arrow) are in the same plane. (d) Needle is advanced past the clip towards the asymmetry on mammogram corresponding to the site on enhancement on prior magnetic resonance imaging. (e) Postlocalization tomosynthesis image shows a single Homer needle coursing just superior to the bowtie-shaped clip marking the site of biopsy-proven ductal carcinoma *in situ* with the distal tip of the needle just superior to the location of the focal asymmetry best corresponding to the enhancing mass. The concave portion of the Homer wire curves inferiorly and encompasses the focal asymmetry.

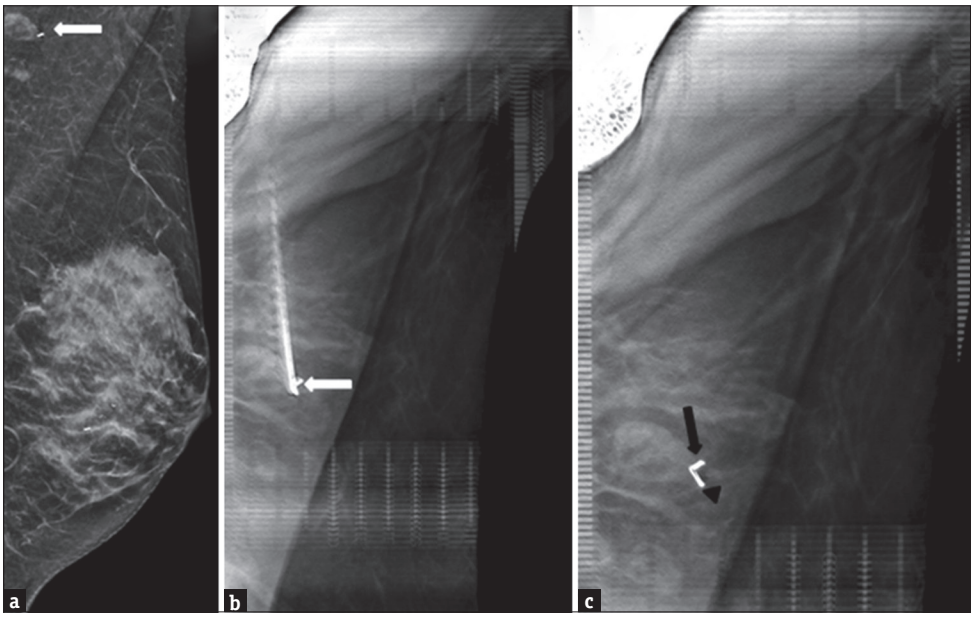

Figure 8: 47-year-old female with biopsy-proven left breast invasive mammary carcinoma and metastatic left axillary lymphadenopathy. Known metastatic lymph node could not be seen under ultrasound at the time of surgery and underwent tomosynthesis guided localization. (a) Diagnostic mammogram mediolateral oblique view demonstrating an axillary lymph node with a biopsy clip (arrow) abutting it. This lymph node was targeted for digital localization using tomosynthesis guidance. The depth from the skin surface was calculated and a seed was placed at the correct depth. (b) Needle being advanced under tomosynthesis guidance perpendicular to the skin surface. The needle tip is seen immediately adjacent to the clip (arrow). A seed was subsequently deployed. (c) Postprocedure mammogram demonstrating both the seed (arrowhead) and the clip (arrow) adjacent to each other.

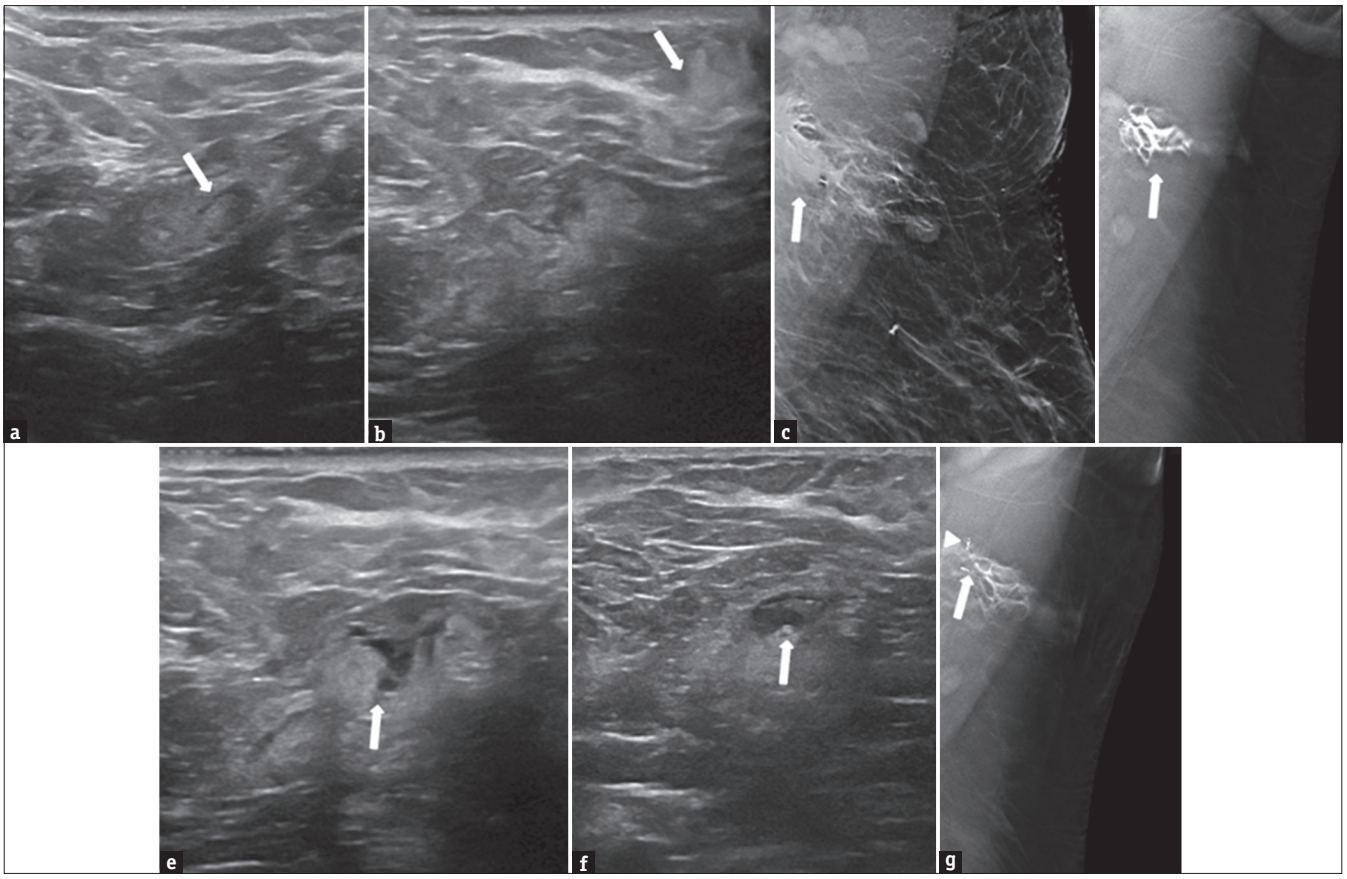

Figure 9: 31-year-old female with left breast invasive carcinoma and malignant axillary adenopathy. 5 months after neoadjuvant therapy, there was sonographic resolution of the pathologic axillary lymph node. Patient subsequently underwent contrast injection for help with ultrasound localization of the clipped metastatic lymph node. (a) Preprocedure ultrasound image demonstrates a morphologically normal lymph node (arrow) after neoadjuvant therapy. The localization clip is not clearly visualized. (b) Static ultrasound image showing injection of contrast (arrow) into the lymph node. A 1 cc injection of a 1:10 solution of sterile Omnipaque 350 and sterile normal saline using sterile technique and local anesthesia with 1% lidocaine with bicarbonate was slowly injected near the lymph node. The contrast appears hyperechoic (arrow). (c) Postcontrast injection mammogram ML view demonstrates contrast in the region of the confirmed clipped lymph node (arrow). (d) Tomosynthesis images demonstrate the contrast to be in the same plane as the clip (arrow) and in close proximity. The patient was then brought back to the ultrasound suite. (e) Hyperechoic contrast is noted with in the lymph node (arrow). (f) Ultrasound static image demonstrating a seed (arrow) placed within the appropriate lymph node. (g) Postseed placement mammogram demonstrating contrast in the region of the clipped lymph node (arrow) and the seed (arrowhead).

Conclusion

When the identified specific lesion cannot be localized in the breast or axilla using conventional methods, other techniques may be employed to aid the surgeon in identifying the site of malignancy.[1,14-20] At our medical facility, we have had success in localizing the more challenging cases using these techniques. Although it sometimes requires logistical and scheduling coordination with other divisions such as CT intervention, we have so far not had a case we were unable to perform preoperative localization.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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