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PICTORIAL REVIEW

Tomosynthesis-guided breast and axillary localizations: tips and tricks

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ABSTRACT

As tomosynthesis is rapidly adopted by breast imaging practices, tomosynthesis-guided procedures are increasingly being performed. Tomosynthesis-guided needle localizations are feasible and efficient and allow for localization of tomosynthesis-only findings or one-view findings, which may be difficult to localize under standard digital mammography. In this review, we describe our step-by-step approach for performing tomosynthesis-guided localizations of the breast and axilla using a standard tomosynthesis unit.

INTRODUCTION

Tomosynthesis is being increasingly used in clinical practice, as it decreases false-positive rate, increases cancer detection rate and decreases screening recall rate.^{1–5} With increased utilization of tomosynthesis for screening and diagnostic mammography, tomosynthesis-guided procedures are also increasingly being performed. Multiple prior studies have described the technique and feasibility of performing tomosynthesis-guided biopsies,^{6,7} but there is overall limited literature on how to perform tomosynthesis-guided localizations.⁸ Tomosynthesis-guided localizations can be performed utilizing an alphanumeric grid on a standard digital breast tomosynthesis unit or by programming a tomosynthesis biopsy attachment, such as Affirm® (Hologic, Bedford, MA), for localizations. In this review, we discuss our step-by-step approach for tomosynthesis-guided seed localizations of the breast and axilla using a standard tomosynthesis unit and explore tips for success and pitfalls to avoid. Although we use radioactive seeds at our institution for wireless localizations, the basic concepts discussed here are applicable to other wireless localization markers.

STEPS FOR PERFORMING TOMOSYNTHESIS-GUIDED SEED LOCALIZATION

Pre-procedural Planning

The very first step in performing a successful tomosynthesis-guided localization is evaluating the target and approach for the procedure. One must assess what the target is (such as a biopsy clip and/or a lesion such as residual calcifications or architectural distortion) and if it is appropriate for

tomosynthesis-guided localization. Lesions that are seen under ultrasound are preferably localized under ultrasound to reduce radiation exposure and enhance patient comfort. Lesions that are seen in two views under 2D digital mammography can be localized under digital mammography or tomosynthesis. However, lesions that are only seen on one mammography view or only seen on or are more conspicuous on tomosynthesis are ideal for tomosynthesis-guided localizations. For example, at our institution, we perform pre-surgical tomosynthesis-guided needle localizations of architectural distortions that are best seen on tomosynthesis and for clipped metastatic axillary nodes which are not well-visualized sonographically in patients after neoadjuvant chemotherapy.

Once a lesion is deemed appropriate for tomosynthesis-guided localization, we determine the best entry approach for the procedure. For lesions only seen on one view, such as axillary lymph nodes, visualization of the needle in that view is necessary. However, for lesions that are seen on two views, two factors should be considered: a) visibility of lesion and b) distance from the skin to the lesion. The patient is then positioned to replicate the view in which the lesion is most conspicuous and/or closest to the skin.

Scout Imaging

After the patient is positioned appropriately, a scout image of the target is obtained with the alphanumeric grid in place. This can be a 2D image with a tomosynthesis image or a tomosynthesis scout image alone. On this image, one must ensure that the target is appropriately positioned within the grid and, if not, the patient must be repositioned

Figure 1. 2D scout images from tomosynthesis-guided localizations targeting a breast (A) and an axillary (B) biopsy clip (arrows). The breast ribbon-shaped clip was localized with tomosynthesis due to breast implants, which limited positioning to one view. White lines demarcate the x (number) and y (letter) coordinates of the target on the alphanumeric grid.

as needed. Once the target is in good position, the alphanumeric grid is used to identify the x and y coordinates of the target (number and letter) (Figure 1). On this image, the z coordinate represents the depth of the lesion. This is assessed by calculating the distance from the alphanumeric grid to the tomosynthesis slice with the lesion in focus (Figure 2)

Needle Placement

Once the x, y and z coordinates of a target have been determined, the skin and the underlying soft tissues are anesthetized as per the lesion location. Then, a pre-loaded seed localization needle using ^{125}I radioactive seed (Best Medical, Springfield, VA) is placed at the pre-determined x and y coordinates and advanced to the z coordinate (depth) calculated previously. As the needle is advanced to the calculated depth, it is essential to keep the needle

Figure 3. Pre-localization tomosynthesis images from tomosynthesis-guided localizations targeting a breast (A) and an axillary (B) biopsy clip (thick arrows) demonstrating the needle tip (thin arrows) in focus near the targeted clips.

straight and at the x and y coordinates of the target. One can utilize the light on the tomosynthesis unit to project the shadow of the needle hub directly over the needle shaft to ensure straight advancement.

Pre-localization Imaging

Once the needle has been advanced to the calculated depth, a pre-localization tomosynthesis image is taken. On this image, one must ensure that the target is still visible and at the location previously determined and that the needle tip is at the target (Figure 3). If the needle tip appears to be too shallow or deep (z axis error), the needle must be advanced or withdrawn as needed. If the needle tip appears to be off the target in the x or y plane, the localization needle must be withdrawn either partially or completely and advanced in the correct x and y planes. Once the needle appears to be at target, one may choose to deploy the seed or assess for accordion⁹ before deployment. Accordion effect as extensively described in the literature previously refers to seed or clip displacement that occurs along the compression

Figure 2. Tomosynthesis scout images from tomosynthesis-guided localizations targeting a breast (A, B) and an axillary (C, D) biopsy clip (arrows). Images A (slice 16 of 51) and C (slice 34 of 78) show the targeted clip in focus while images B (slice 46 of 51) and D (slice 73 of 78) show the alphanumeric grid most in focus. Slice numbers are subtracted to calculate target depth (z): $46-16 = 30\text{mm}$ for the breast clip and $73-34 = 39\text{mm}$ for the axillary clip using 1mm slice thickness.

Figure 4. Pre-localization tomosynthesis image (A) from tomosynthesis-guided localization targeting a breast biopsy clip (thick arrow) demonstrating the needle tip (thin arrow) in focus near the targeted clip. Post-deployment tomosynthesis image (B) shows the seed (arrowhead) in position adjacent to the clip. Post-procedural full-field ML C-view (C) shows the seed has migrated superiorly along the z axis when compression was released due to the accordion effect. The clip was targeted via a CC approach.

axis (z axis), when the breast is decompressed (Figure 4).⁹ Before seed deployment, one may reduce the compression and assess on a repeat image if the needle is still at target before deployment and make adjustments if necessary.

Seed Deployment and Post-localization Imaging

Once the needle is thought to be in a satisfactory position, the seed is deployed at target. Another tomosynthesis-guided image is acquired at this point to ensure that the seed is near the target (Figure 5). The patient is then released from compression.

Post-procedural Imaging

After a tomosynthesis-guided localization at our institution, we obtain a full-field craniocaudal and mediolateral image for a lesion localized in the breast and a mediolateral oblique or

axillary tail view for an axillary lesion. We also initial the skin at the site of the needle entry to guide our surgeons.

PITFALLS

Although tomosynthesis-guided seed localizations are technically feasible and efficient, one must be aware of potential complications. Displacement of the seed has been reported previously with tomosynthesis-guided localizations,⁸ but this can occur with any digital mammographic procedure. Our technique of assessing for accordion reduces the risk of displacement. Misplacement of the seed in the pectoralis muscle has also been reported previously in tomosynthesis-guided axillary localizations.⁸ This can particularly happen with targets that are very deep in the axilla. Strategies such as placing the needle slightly deeper than the calculated depth⁸ and success of alternative localization methods, such as CT-guided localizations,¹⁰ have been previously described. Some targeted axillary nodes or clips may also be adjacent to large blood vessels, and it may be difficult to find a tomosynthesis-guided needle trajectory to avoid injury to those vessels. In such cases, alternative approaches may be considered. However, in all cases of tomosynthesis-guided localizations, and particularly axillary localizations, one must weigh the risks versus benefits of localizing under tomosynthesis, localizing under an alternative modality, or not localizing at all. Shared decision-making between the patient, the surgeon and the radiologist is essential in such challenging localization cases.

CONCLUSIONS

As tomosynthesis-guided procedures are increasingly being performed in clinical practice, breast radiologists must learn the proper technique to perform tomosynthesis-guided localizations and be aware of potential pitfalls. This step-by-step review, based on our success with tomosynthesis-guided localizations, provides a guide for radiologists wanting to implement this technique in their practices. Proficiency in tomosynthesis-guided localizations provides practices with an alternative method of pre-surgical localization in patients who cannot have ultrasound-guided or digital mammography-guided needle localizations.

Figure 5. Post-deployment tomosynthesis images from tomosynthesis-guided localizations targeting a breast (A) and an axillary (B) biopsy clip (thick arrows) demonstrating the seed (arrowheads) in focus near the targeted clips

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