

Breast Biopsy Workflow with syngo MR XA20 – How I Do It

Sarah-Jane Lewis

Siemens Healthineers UK and Ireland

Background

During the investigation of a breast lump or suspicious lesion, the patient may undergo several modality examinations. The dynamic contrast-enhanced MRI scan is highly sensitive [1] at demonstrating lesions and may lead to the discovery of a lesion only visible on the MRI scan, a so-called MRI-only lesion. If the lesion is only visible with MR imaging, the biopsy must be performed under MRI guidance. Clinical sites that perform breast MRI in the UK are expected to either perform or have access to a referral site that performs MRI-guided biopsy.

This article provides an overview of MR-guided breast biopsy performed using the Breast Biopsy software, syngo MR XA20 version (Siemens Healthcare, Erlangen, Germany).

Introduction

A breast biopsy itself may involve several stages: A standard procedure involves a vacuum-assisted biopsy (VAB) using an MRI-compatible biopsy system. The biopsy console unit is not MRI-compatible and must remain outside the scan room. There are several manufacturers of such devices and the biopsy arm should be checked for MRI compatibility along with the foot pedal used to control the tissue removal. Targeting is performed using an MR Safe introducer kit that includes a needle guide for accurate positioning and an obturator that helps both to stem the flow of blood and to confirm the location. Once the main biopsy has been performed, the radiologist may leave a hookwire or marker *in situ* for further surgery or biopsy site evaluation. Sterile disposable grids are also required. Consequently, good preparation is essential before each examination due to the large amount of specialist consumable items needed. It is recommended that procedures are reviewed and workflows are practiced regularly at the clinical site to maintain the competency to perform breast biopsy. Clinical sites are expected to perform at least 10 biopsies a year to maintain their competency [1].

Right		Left	
t1_fl3d_nonfs_sag_1+2_right	07:41	t1_fl3d_nonfs_sag_1+2_left	07:41
t1_tse_tra_right	02:04	t1_tse_tra_left	02:04
t1_fl3d_sag_cavity_right	02:08	t1_fl3d_sag_cavity_left	02:08

1 Right and left breast may be separated to activate specific coil elements

Equipment

The procedure was performed on a 1.5T MAGNETOM Sola system with *syngo* MR XA20 software and the Breast Biopsy software license. A grid system was used, which is available for the 2-/10-/16-channel and 2-/4-/8-channel Sentinelle Breast Coils, and the Breast BI 7 coil. The grid is the biopsy system used most in Great Britain and Ireland (GB&I) and is the method described in this article. The Breast Biopsy software, however, also supports the post and pillar approach in combination with the Breast BI7 coil.

Preparation

The patient is required to lie prone, and the procedure may take as long as 45 minutes. It would be advisable to encourage the patient to empty their bladder and to avoid heavy meals for a couple of hours prior to the procedure. A cannula is required for IV contrast. The patient may need to place their hands above their head in a "Superman-style" position, so it may be advisable to place the cannula in the wrist if the elbows are to be bent for the procedure. A useful procedure seen at several sites within GB&I is to have a meeting prior to the procedure and delegate the tasks required. For example, a metallic scalpel may be used, and a designated person will be responsible for making sure it is safely brought into, and removed from, the scanning room. Additionally, the radiologist performing the procedure should confirm the anatomical site or sites to be biopsied. This can be performed at a PACS workstation or the MR system itself. The location of the potential biopsy site is important as this can influence how the breast is positioned within the grid. With a biopsy site toward the axilla, the patient may need to lie slightly obliquely on the table to ensure the axillary tissue is pulled into the grid area. Equally, if the biopsy site is toward the chest wall, the breast tissue needs to be pulled quite firmly away from the chest into the grid. If a medial approach is considered, then the contra-lateral breast will need to be lifted out of the way using the breast plate and the grid and fiducial placed on the medial side. If the exact approach is not known beforehand, the breast will need to be compressed medially using a second grid with a second fiducial. Most radiologists will generally attempt a lateral approach if possible as the access is more open, therefore making the procedure easier. Once the patient is lying on the patient table with the cannula attached to the contrast pump, the breast should be immobilized within the biopsy grid device by providing moderate compression. The positioning of the grids should be supervised by the radiologist to ensure optimum compression. Compression is needed to immobilize the breast but also to prevent stretching or tenting of the subcutaneous tissue when the introducer needle is pushed in and out of the breast. Compressing the breasts also has the advantage of

creating a smaller volume of tissue to scan, which is useful in volume scanning to reduce the number of slices required. The level of compression also needs to be balanced against the risk of reducing visibility of the lesion by applying too firm a compression [2].

The fiducial should be placed in a grid opening. With the Sentinelle Breast Coil, the fiducial is placed at C4 as standard. The use of the same grid opening every time a biopsy is performed allows continuity and reduces any potential user error due to a wrong fiducial position. As the grid position is not fixed, a marker is crucial as it is used to establish a reference position for needle insertion.

Scanner protocols

The design of the biopsy scanning protocols varies slightly from that of the diagnostic protocol. The number of different sequences should be truncated to reduce the scanning time. The sequences will always start with a localizer. These should be looked at to assess the quality of the compression and to ensure that a good proportion of the breast tissue is included in the coil. If there is a roll of tissue above the grid, it may be possible to reposition the patient by releasing the grid and allowing more tissue to fall into the grid area. The localizer can also be used to assess the filling of the fiducial marker with diluted contrast medium when using the Siemens Healthineers Breast BI 7 coil and NORAS Breast Biopsy Set (NORAS MRI products, Höchberg, Germany). It may not be necessary to include any sequences prior to the dynamic run, the exception to this is if the suspected tumor area is shown particularly well on a non-enhanced sequence, such as T2 axial. Dynamic sequences will consist of a 3D gradient echo T1 in the sagittal plane without fat saturation. Sagittal acquisition is performed so that the slices are parallel to the grid plane. No angulation can be used. Inline subtraction is included for easier visualization of the tumor. The number of phases required should be discussed at the site level as there may be some delayed enhancement due to the compression of the breast and feeding blood vessels [2]. The initial phases are automatically loaded into the workflow as soon as they are reconstructed so these can be used to start the configuration whilst the later phases are obtained. Therefore, there is no time-saving advantage to keeping the number of dynamic phases too low. The automatic opening of the Breast Biopsy workflow is triggered by the **Advanced Application** add-in and, once completed, subsequent sequences will be loaded into the appropriate segments of the workflow. A decision within the strategy can be used to separate right and left breasts to have specific coil elements activated, as shown in Figure 1. Additionally, predetermined offsets in the sagittal dynamic blocks can be used to save a small amount of time when setting up the sequence.

Biopsy workflow

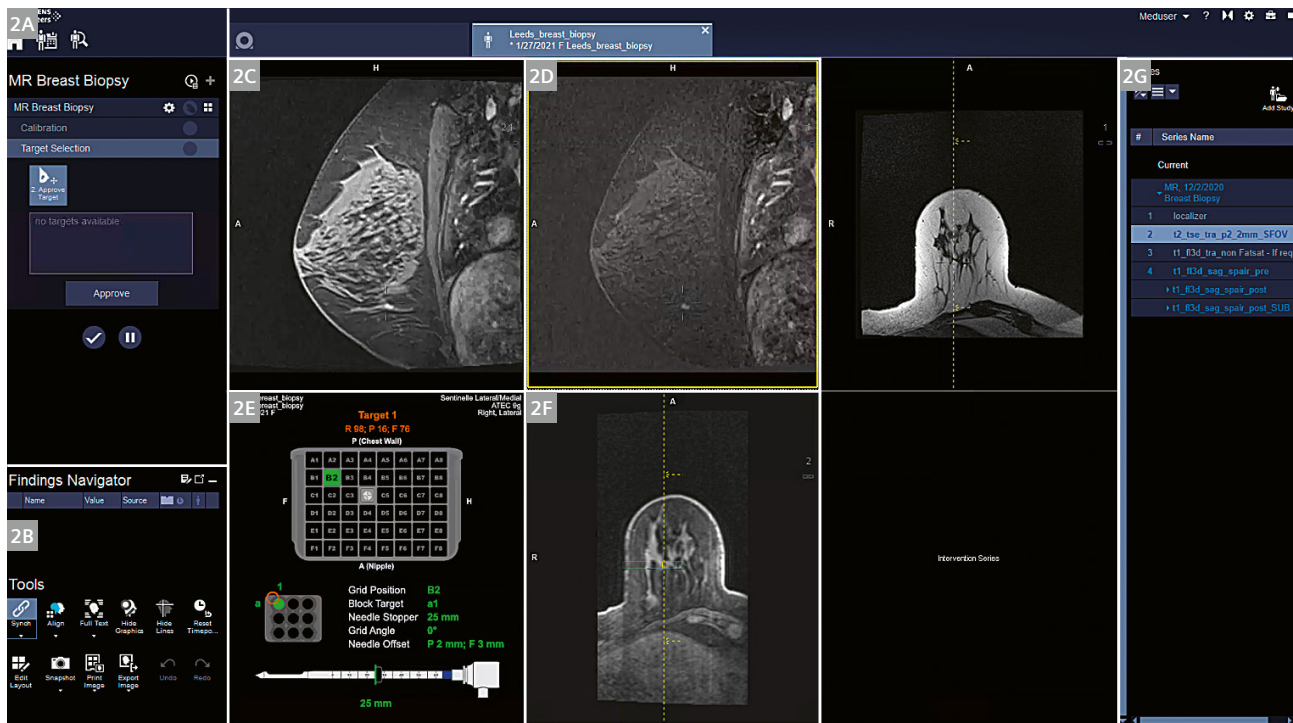
The patient is registered. During registration, the previous diagnostic images can be recalled from the PACS and will be available in the Breast Biopsy workflow. If this step is missed, then the images can be added to the Breast Biopsy workflow using the **Add Study** button in the Series Navigator. An overview of the whole layout is shown in Figure 2. Once the dynamic run is started, an IV injection is performed between the first and second phases, with the first phase acting as the subtraction mask or subtrahend. When the injection has been completed, your attention can turn to the Breast Biopsy workflow. The automated loading of sequences should have started, and the first dynamic phase can be used to begin the calibration step. The calibration workflow step contains all the information relating to the equipment used and the position of the fiducial. This step can be completed by the technologist in conjunction with the radiologist. The device menu enables the user to select from a list of pre-configured settings, depending on what equipment is in use.

In the normal scenario, only a small number of presets should be needed as similar methods will be used each time. Usually, a site only possesses one biopsy coil and the same type of needle device kit is normally used. If the fiducial is placed into the same grid square each time, this naturally limits the number of presets needed. When configuring presets for the Sentinelle Breast Coils, only

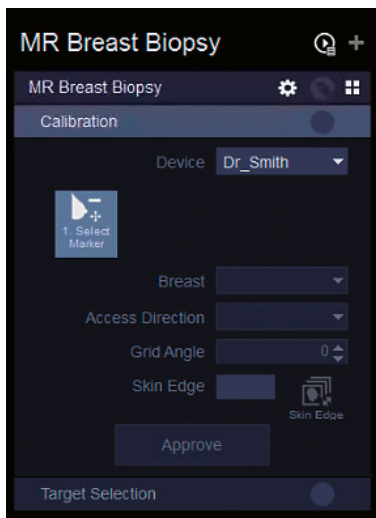
a C4 marker position is possible. These presets can be configured prior to scanning and quickly amended during the exam, if needed. Configuration of the device setting presets is accessed via the cogwheel icon as shown in Figure 3. The presets can be named as required after the radiologist using them or the individual needle types as shown in Figure 4.

Once the device preset has been selected, then the fiducial needs to be located. As soon as the images start arriving in the workflow, they will load with the native sagittal images in the top-left segment and the inline subtractions in the top middle segment. The middle mouse button or the keyboard arrows allow you to scroll through the images to locate the fiducial, which will be seen in cross-section on the sagittal as a dot. In the bottom middle segment, an MPR image allows you to see the length of the fiducial in the transverse plane. Click the **Marker Position** icon to activate the crosshairs. To mark the fiducial, place the crosshairs on the end of the fiducial closest to the breast as shown in Figure 5. Click the **Approve Marker** icon to confirm the marker position and set the **Access Direction**, which can be seen in the drop-down field. As the breast is compressed and the fiducial is pushed against it in the grid, the fiducial is marking the skin surface.

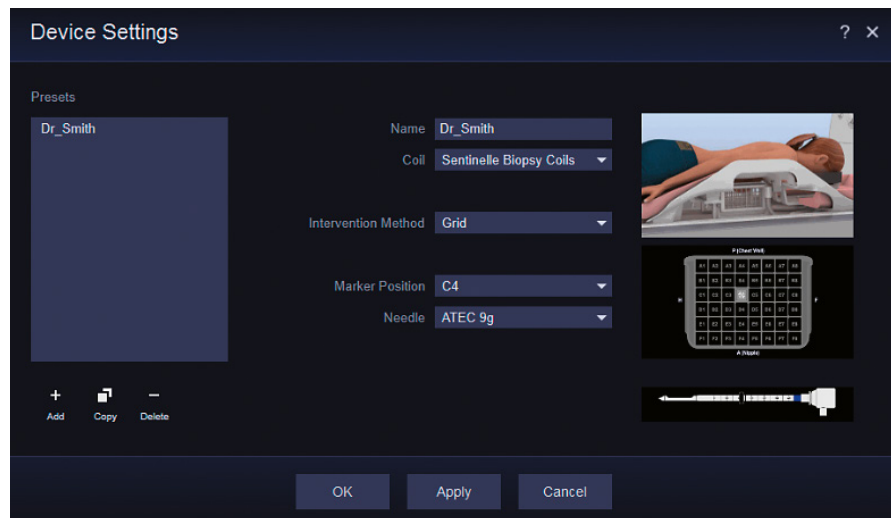
The slice position of the skin surface is visible in the **Skin Edge** field, which gives a slice position in the right or left direction. This skin surface location is needed for the depth measurement calculation. If the radiologist wants to



2 2A Workflow steps, 2B Tools and Findings Navigator, 2C targeting segment with native sagittal images, 2D subtracted sagittal images, 2E graphics for the targeting information, 2F MPR of native images, 2G Series Navigator

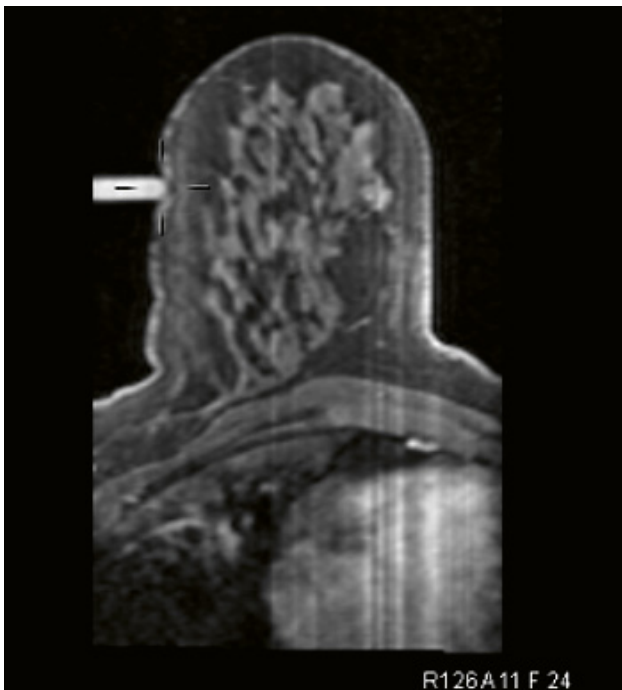


3 Calibration step



4 Device settings

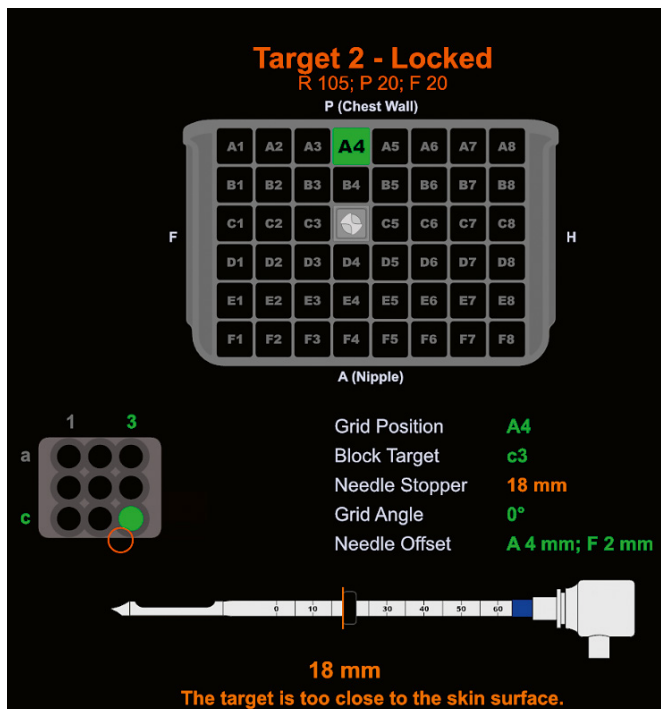
change this skin surface, this can be done by clicking the **Skin Edge** button. By scrolling through the native sagittal images, you can visualize the grid and the skin protruding through the grid squares. By clicking **Approve** (skin edge), you reset the skin edge and a purple grid overlay allows you to visualize where the skin edge and grid are. Selecting the device preset and determining the marker position are necessary calibration steps that must be completed prior to locating the target lesion. Click **Approve** to complete



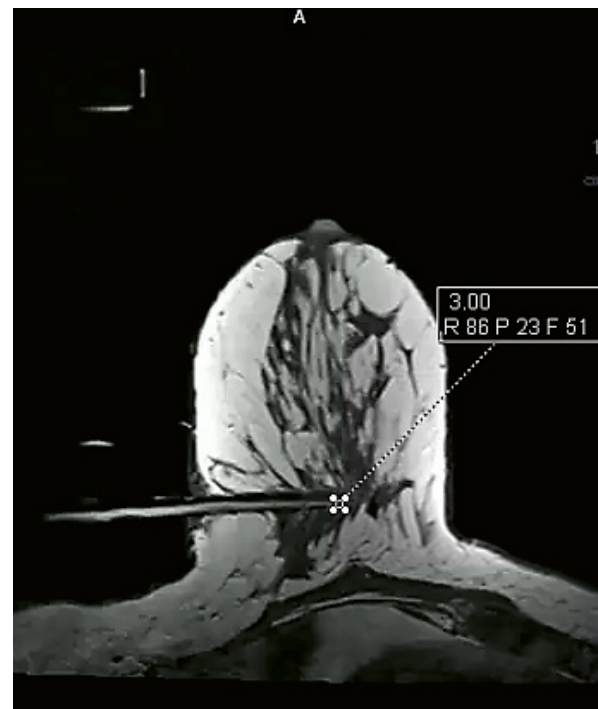
5 Marking the fiducial

the **Calibration** workflow step and lock these values in. If a double fiducial method has been used and then subsequently the alternate fiducial needs to be used, the preset can be changed mid-workflow. This might be needed if a lateral approach was planned but then the tumor position dictated that a medial approach was needed.

After approving the **Calibration** step, the **Target Selection** step is opened. The **Approve Target** tool is active, and the mouse pointer is displayed as crosshairs. If this is not required at this time, then the escape key can deactivate the tool. The radiologist can now view all images to see where the biopsy needs to be performed. Once a site has been chosen, the **Add Target** tool can be activated again and a mouse click on the lesion creates a target. At this point, the target has not yet been confirmed and pressing **Escape** removes the target. Alternatively, simply clicking in another place moves the target. Once the radiologist is satisfied with the target, the **Approve Target** button can be clicked. After this action, a finding will be created with images of the target, which can then be sent to the PACS. The target also appears in a list of targets that can be displayed on the Select&GO panels in the scan room. This is useful if multiple targets are obtained. The software has now calculated the depth and position of the target and this is displayed in the bottom-left segment. The graphic (Fig. 6) shows the exact position in the coordinate system, so this can be cross-referenced later with the pixel lens, if needed. Additionally, the needle system is displayed along with the depth measurement. If the target is within 20 mm of the skin surface on the fiducial side, then a warning will be displayed. The decision to proceed or not then lies with the radiologist. The side of the breast on the non-fiducial side has not been marked or delineated from the system, so the only limitation here is the depth of the lesion and the limitations of the needle system. On a small



6 Graphic showing the exact target position in the coordinate system



7 Transversal scan at the level of the obturator

breast, the targeting can be quite close to the far edge of the breast and no warning is issued, so the staff must carefully check that they are not going to biopsy partially outside of the breast. The biopsy needle samples from a trough or notch along the length of the needle. The calculated depth positions the target in the middle of the notch, meaning that some of the needle and notch extends beyond the target point. The target coordinate display also gives information about the target selected by the radiologist and the nearest possible needle block position. The available target positions are limited by the grid walls themselves, and the needle block only has pre-determined positions. The red circle shows the target position marked and the green circle shows the nearest possible grid block opening. The **Needle Offset** shows the distance in mm that differs between these two positions. If the position is not precise due to the internal wall of the needle block, then the radiologist can make the decision to remove the needle block and perform the biopsy freehand. This requires experience and a steady hand as the needle block helps keep the biopsy arm perpendicular to the grid. If the position of the biopsy is not perfect due to the grid wall, not much can be done to move the needle itself to this position. However, when performing the vacuum biopsy, the radiologist can decide to concentrate the biopsy in this direction. So in Figure 6, the red circle/lesion is in a 7 o'clock position relative to the green circle/needle, so the radiologist could decide to perform more biopsy samples

here rather than more posteriorly toward the chest wall. Select the desired target and click **Send** to display the target coordinates on the Select&GO display in the scan room. In the example in Figure 6, the target is within 20 mm of the skin surface, so a warning is issued.

The first part of the intervention involves inserting the coaxial introducer sheath to create a pathway to the target. The patient table should be moved out of the scanner bore and the table lock applied from the Select&GO display. The radiologist will then inject some local anesthetic into the desired area through the biopsy grid. As soon as the area is numb, a small cut is made with a scalpel. Then the needle block can be inserted into the appropriate grid segment. If the required segment happens to be C4, where the fiducial is, then this will need to be carefully removed to make way for the needle block. Once the needle block is *in situ*, the radiologist can view the Select&GO display and select the depth measurement. Depth markers on the introducer sheath are used to insert the needle to the calculated depth, within the correct position in the needle block. Once the coaxial introducer has created the pathway, then the inner stylet can be withdrawn and replaced with the obturator. The table is unlocked, and the patient table is moved back into the scanner bore. A transverse scan is performed at the level of the obturator as shown in Figure 7. This scan can be performed at a slightly higher resolution than the dynamic run and is used to confirm the position of the obturator and can be positioned using the

known coordinates of the target as given in the target graphic. The transverse scan is looked at to confirm that the obturator is in a good position relative to the target. This workflow needs to be performed quickly as ideally the lesion would still retain some contrast on this scan, to be able to visualize it. If the obturator is not in the ideal position, the radiologist can either decide to reinsert the stylet and adjust the depth or can adjust on the fly. For example, frequently the intervention pushes the lesion slightly further away, toward the far side of the breast side. In this case, radiologists may make the adjustment to this as they go, simply by pushing the biopsy device further in.

Once the vacuum biopsy is completed, a post-biopsy image is acquired. A large void will be seen at the site of the biopsy and it can be confirmed that the lesion has been removed or sampled. It is likely that a post-biopsy clip will then be implanted to act as a marker for further imaging or interventions. Many sites do not perform imaging after the implantation, as it can be difficult to see a small clip in a large area of bleeding.

The findings created contain images that can be sent to the PACS using the **Save and Send** function when closing the MR Breast Biopsy workflow.

Troubleshooting tips

There may be occasions when the configuration needs to be changed during the exam. For example, the needle type may need to be changed if the biopsy is located quite close to the skin edge. This can be done by configuration of a device preset on the fly. This can be performed in the device

settings by copying the current preset and then changing the needle type. This will be loaded automatically without any changes to the original images, fiducial position and targeting. However, you can only access the **Device Settings** menu if you selected **Modify** in the **Calibration** step. Also, you may want to change the direction from lateral to medial approach. Again, this can be done by clicking the **Modify** button in the **Calibration** step and redefining the marker position on the medial side.

Sometimes you will need to view the sagittal images in an alternate orthogonal plane. This can be done by using the blue orientation cube on the right side of the display segments. By left mouse clicking on the cube you rotate through sagittal, transverse and coronal in turn. By right-clicking on the cube, you can select the orientation of choice. Additionally, you may want to view the subtraction images as a maximum intensity projection (MIP), which is done by selecting **MIP** in the bottom-left corner menu.

With **MIP** selected, you can scroll through the phases using the movie tool, which you can start by pressing the spacebar or by opening the top-left corner menu. If you have left the orientation of the images in a slightly odd position and wish to reset them, double-clicking the blue orientation cube will reset the orientation back to sagittal.

Acknowledgment

Thank you to the Radiology Department at St. James Hospital, Leeds, England for the kind use of their images.

References

- 1 Sardanelli et al., Magnetic resonance imaging of the breast: Recommendations from the EUSOMA working group. *Eur J Cancer*. 2010 May;46(8):1296-316. doi: 10.1016/j.ejca.2010.02.015. Epub 2010 Mar 19.
- 2 El Khouli et al., The effects of applying breast compression in dynamic contrast-material enhanced MRI Imaging. *Radiology*. 2014 Jul;272(1):79-90. doi: 10.1148/radiol.14131384. Epub 2014 Mar 12.

Contact

Sarah-Jane Lewis
MRI Applications Specialist
Siemens Healthcare Limited
United Kingdom
Phone: +44 7808 822444
sarah-jane.lewis@siemens-healthineers.com

