Imaging Findings Following Breast Reconstruction with Autologous Fat Stem Cell

Poster No.: C-0140
Congress: ECR 2013
Type: Educational Exhibit
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Keywords: Breast, MR, Mammography, Ultrasound
DOI: 10.1594/ecr2013/C-0140

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Learning objectives

- Describe the different breast abnormalities that may occur following reconstructive surgery using stem cells injection derived from autologous adipose tissue.

- Describe the imaging findings of these breast abnormalities.

Background

Currently, malignant breast tumours are treated whenever possible by partial mastectomy or lumpectomy, resulting in breast asymmetry or deformity. The techniques of reconstructive breast surgery continue to evolve, in order to improve cosmetic results. For this purpose, various studies, using fat stem cell injection, are being conducted to repair volume defects and other deformities.

In 1987, the American Society of Plastic and Reconstructive Surgery recommended the prohibition of autologous fat cells injection in breast tissue because it could affect breast cancer screening. However, recent studies suggest that this technique is effective in breast volume reconstruction and that the knowledge of potential complications allows maintaining a good sensitivity for breast cancer screening. Despite this, the complexity of imaging tests interpretation remains a major concern with this procedure.

Given that this technique continues to be used in some centers, including ours, we decided to review the complications that could be observed and their imaging appearance. Such alterations include fat necrosis, post-surgical scars, hematomas/seromas, and local tumour recurrence.

Imaging findings OR Procedure details

Fat Necrosis:

Fat necrosis incidence after graft of fats cells varies widely in different studies, usually appearing in more than 20% of cases.

Fat necrosis is a vascular insult to fat cells. A cascade of cellular events occurs, beginning with the initial damage, resulting in a variable appearance on imaging tests. Initially, a focal area of haemorrhage and infiltration of inflammatory cells develops on fat.
Subsequently, the fat cells undergo necrosis and liquefaction and there is increase in vascularisation and infiltration with fibroblasts, lymphocytes and histiocytes on necrosis focus wall. Finally, the necrosis focus can be replaced by scarring tissue or persists as an oil cyst surrounded by fibrous tissue. Wall calcification is very common in oil cysts.

Fat necrosis usually is asymptomatic, but can causes palpable smooth mobile masses or even irregular palpable masses with overlying skin retraction.

The imaging appearance of fat necrosis correlates with the degree of fibrosis.

Mammography findings:

- Oil cysts: in cases with low fibrosis, fat necrosis appears as oil cysts. On mammograms, oil cysts appear as rounded or oval radiolucent nodules, with circumscribed margins and a thin peripheral ring of fibrosis that may or may not calcify (Fig. 1 and 2). Occasionally a fat-fluid level can be seen in oil cysts.

- Calcifications: fat necrosis often shows curvilinear calcifications on oil cysts walls or can show a calcified rim surrounding a radiolucent centre (eggshell-type) in millimetric fat necrosis. Thus, mammographic appearance of oil cysts is usually benign. However, early fibrous rim calcifications and the collapse of a partially calcified cyst may produce an indeterminate appearance. Infrequently, fat necrosis can appear as clustered pleomorphic microcalcifications, indistinguishable from malignancy. Fat necrosis can also present as dystrophic calcifications (Fig. 3)

- Focal asymmetries and spiculated nodules: when fibrosis predominates, fat necrosis can be seen as a focal asymmetry or a spiculated nodule with or without pleomorphic or dystrophic calcifications associated. (Fig. 4)

Ultrasound findings:

The ecographic appearance of fat necrosis depends also on the associated degree of fibrosis. Fat necrosis may appear as anechoic cystic nodules with posterior enhancement, hyperechoic solid masses, and complex lesions with mural nodules or echogenic debris. When fibrosis predominates, fat necrosis presents as solid nodules with spiculated margins (Fig. 5 and 6).

The absence of vasculature on ultrasound supports the diagnosis of fat necrosis, but does not exclude malignancy.

Magnetic resonance imaging (MRI) findings:

As in other imaging tests, the MR appearance of fat necrosis depends on the fibrosis degree and the associated inflammatory response.
The appearance on MRI include oil cysts with a variable thickness wall with or without fat-fluid level and, and solid nodules of ill-defined or spiculated margins.

Oil cysts are the most common finding in fat necrosis on MRI. They are seen as rounded or oval nodules, hyperintense on T1-weighted images, which suppress in fat suppression sequences (Fig. 7). Fat-fluid level may or may not be present (Fig. 8). The wall thickness of oil cysts also depends on the degree of fibrosis associated (Fig. 9).

Sometimes, coarse calcifications on the walls of oil cysts may be seen as void signal (Fig. 10), however small calcifications are not usually identified.

Lesions without macroscopic fat in which fibrosis predominate may be seen as spiculated nodules with hypointense signal in all pulse sequences.

Oil cyst walls and fat necrosis nodules can enhance contrast in variable degrees, depending on the associated inflammatory reaction. Commonly, a thin ring of enhancement is present, whereas thick irregular or spiculated walls are infrequent (Fig. 11 and 12). Enhancement can be either homogeneous or heterogeneous, with variable kinetics, ranging from slow to rapid uptake, followed by a persistent, plateau or even early washout curve in the absence of malignancy. This enhancement depends on the inflammatory reaction, meaning it usually decreases as the later resolves.

When fat necrosis diagnosis cannot be established based solely on imaging findings, a biopsy should be considered for histological confirmation.

**Post-surgical Scars:**

Post-surgical scars are usually seen as irregular nodules with spiculated margins in all imaging tests. On ultrasound, they may exhibit acoustic shadowing. On MRI they are usually hypointense on T1-weighted sequences (Fig. 13), with more variable signal on T2-weighted sequences. Following contrast administration, scars can present variable enhancement kinetics, depending on the inflammatory reaction and sometimes requiring a biopsy to exclude a tumour recurrence.

**Hematoma/seroma:**

After breast reconstruction with autologous fat stem cells, hematomas and seromas can be observed, and typically reduce in size over time. On mammography, hematomas/seromas usually appear as circumscribed masses, but ill-defined borders can be present as well. On US, acute hematomas have high echogenicity, whereas in subacute and chronic phases hematomas present as complex collections with septa and echogenic debris. Seromas, on the other hand, usually present as anechoic collections, sometimes with septa. On MRI, hematomas’ signal varies with time. In the subacute phase,
hematomas may show parietal enhancement secondary to the associated inflammatory component.

**Tumour recurrence:**

Tumour recurrence usually presents as suspicious nodules on mammography, U.S. and MRI (usually with spiculated margins in all imaging tests, posterior acoustic shadowing and taller-than-wide configuration on US, and suspicious enhancement curves in RM) (Fig. 14). Sometimes it undistinguishable from post-surgical scars and fibrotic fat necrosis, and histological confirmation is mandatory.

**Images for this section:**

**Figure 1. Oil Cysts.**

Oil Cysts are pathognomonic of fat necrosis.

They appear as rounded or oval radiolucent nodules, with circumscribed margins and a thin peripheral ring of fibrosis that may or may not calcify.

MLO mammograms show multiple oil cysts. On the left, oil cyst have parietal calcifications (arrow) whereas on the right, oil cysts show a thin peripheral ring without calcification (arrowhead).

Fig. 1
Figure 2. Oil Cysts.

There are numerous scattered oil cysts. Some show parietal calcifications (arrow) and others do not (arrowhead).
Figure 3. Fat Necrosis associated Calcifications

Arrow: eggshell-type calcification in a calcified oil cyst.

Arrowhead: rim of fibrous calcifications in oil cysts that appear as indistinct calcifications.

Void arrow: dystrophic calcifications in a fat necrosis focus.

Sometimes, fat necrosis can appear as clustered pleomorphic calcifications, indistinguishable from malignancy.

Fig. 3
Figure 4. Thick walled Oil Cyst

According to the degree of parietal fibrosis associated to a oil cyst, varies the degree of wall thickening and spiculation. When fibrosis predominates, fat necrosis also can be seen as a focal asymmetry or a spiculated nodule.

On the left, MLO and CC mammograms show an irregular nodule, with spiculated margins surrounding a radiolucent center, corresponding to an oil cyst with thickened fibrotic walls.
On ultrasound, fat necrosis may appear as anechoic cystic nodules (oil cyst) with or without parietal calcifications. Parietal calcifications are seen as a parietal echogenic line. Sometimes, oil cysts may appear as complex cystic lesions with solid components.
Figure 6. Ultrasound Findings in Fat Necrosis

Fat necrosis may appear as a solid hyperechogenic nodule.

Fat necrosis may appear as an architectural distortion focus (arrows).

Fat necrosis may appear as a hypoechogenic nodule with posterior acoustic shadowing and spiculated margins, findings highly suggestive of malignancy.

Fig. 6
Figure 7. Oil Cysts - MRI

Oil cysts appear as hyperintense nodules on T1-weighted sequences (left) which suppress in fat suppression sequences (right).

Fig. 7
Figure 8. Oil Cysts - MRI

Oil cysts can present a fat – fluid level.
Figure 9. Oil Cysts - MRI

Void signal on MRI secondary to coarse calcifications on the wall of an oil cyst.

Fig. 9
Figure 10. Oil Cysts - MRI

As in other imaging tests, the wall thickness of oil cysts depends on fibrosis degree.

The MRI on the left shows an oil cyst with a thick wall.
Figure 11. Oil Cysts - MRI

Oil cyst with a thin peripheral ring of enhancement.

Fig. 11
Figure 12. Fat Necrosis - MRI

MRI shows fat necrosis as a nodular focus of enhancement with spiculated margins. Initial enhancement is rapid with late phase washout (type III curve). These findings are secondary to the inflammatory response associated to fat necrosis.

Fig. 12
Figure 13. Postsurgical Scars after Breast Reconstruction with Autologous Fat Stem Cells.

Breast MRI - Sagittal T1 – weighted sequences. In these three patients with partial mastectomy and breast reconstruction with autologous fat stem cells, MRI shows postsurgical scars as hypointense nodules with spiculated margins.
Figure 14. Tumor Recurrence after Breast Reconstruction with Autologous Fat Stem Cells.

CC mammograms (left) and breast MRI sagittal T1 – weighted sequence (right). Patient with a history of ductal invasive carcinoma treated with partial mastectomy and breast reconstruction with autologous fat stem cells. Both imaging tests show a spiculated nodule corresponding to a tumor recurrence.
Conclusion

After injection of autologous fat stem cells in breast region, the development of fat necrosis is frequent. Fat necrosis usually presents as oil cysts, which usually have a characteristic appearance and are easily detected on imaging tests. However, wall calcification of oil cysts may be misleading or even hide pleomorphic calcifications. Additionally, fat necrosis can cause architectural distortions and nodules with radiological malignant features, which may warrant a biopsy. However, fat necrosis and post-surgical scars can be seen with any invasive procedure or breast surgery (biopsy, breast reconstruction and prosthesis). In various studies and in our own experience most autologous fat stem cell injection related findings show benign radiological features, being oil cysts the most common change after this procedure.

References

Personal Information