Sonographic features of inflammatory conditions of the breast

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Abstract

Inflammatory conditions of the breast can be a diagnostic challenge, and ultrasound is a proven valuable tool in this setting. In acute infective conditions, ultrasound is often a superior tool to mammography due to the impracticality of applying compression to the breast and the increased parenchymal density of these often younger patients. Although infective processes comprise the majority of inflammatory conditions in the breast, not infrequently other various disease processes can masquerade as infections. In particular, inflammatory breast cancer can be easily misdiagnosed as an infective process and sonography can play an important role in expediting the correct diagnosis. Furthermore, aspiration, drainage and biopsy are frequently required in managing breast inflammation and breast disease generally, and ultrasound is the most practical imaging modality facilitating such interventions. This article provides a review of the ultrasound characteristics of some of the more frequently encountered inflammatory disorders of the breast which span a spectrum of acute to chronic conditions. The various conditions in this report are described in terms of their specific sonographic imaging features as well as pathogenesis, common clinical presentations, and aspects of management are outlined where appropriate.

Keywords: sonography, breast, inflammation.

Introduction

Inflammatory conditions of the female breast encompass a broad spectrum of diseases and also reflect a variety of underlying aetiologies. Kamal[1] has very appropriately classified inflammatory disorders of the breast into three categories: (i) infectious mastitis, (ii) non-infectious mastitis and (iii) inflammation related to breast malignancy.

While infective mastitis more frequently occurs in the setting of pregnancy and breastfeeding, non-lactational breast infections and abscesses are not uncommon.[2] Non-infective causes of mastitis include duct ectasia or periductal mastitis, granulomatous mastitis and fat necrosis. The scenario of a patient with mastitis who does not respond to antibiotic therapy should raise suspicions as to the possibility of inflammatory breast carcinoma.[3,4]

High-frequency breast ultrasound plays a very important role in evaluating and diagnosing inflammatory breast disorders, and indeed ultrasound together with needle interventions provide the most useful means of assessing most inflammatory breast conditions. The purpose of this article is to provide a descriptive and pictorial review of the ultrasound characteristics of some of the more usual inflammatory conditions affecting the breast. In selected instances, aspects of treatment will also be discussed.

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Ultrasound signs of breast inflammation

Breast inflammation is usually associated with oedema and thickening of the skin, and ultrasound provides a very useful means of assessing skin thickness by comparing the measurements on the affected breast with those of the skin on the contralateral breast.[3] Subcutaneous oedema is evidenced on ultrasound by the presence of a diffuse increase in the thickness and echogenicity of the subcutaneous tissues (Figure 1).

Breast hyperaemia or increased vascularisation of the breast tissues is another important sign of inflammation and can be demonstrated on Doppler ultrasound by increased arterial and venous structures.[5] Ultrasound is very useful for also assessing the major lactiferous ducts deep to the nipple for signs of ectasia, thickening of the wall, inspissated contents or abscess formation.

Progression from the stage of cellulitis to frank abscess formation is associated with the development of a poorly defined anechoic or hypoechoic fluid-filled space containing a few irregularly distributed internal echoes.

Axillary lymph nodes can also be very effectively assessed by ultrasound. Lymphadenopathy is most commonly reactive in nature and is seen as a response to benign inflammatory conditions. In the context of breast inflammation metastatic disease from inflammatory carcinoma always needs to be considered. In normal lymph nodes, the cortical thickness is usually less than 4 mm

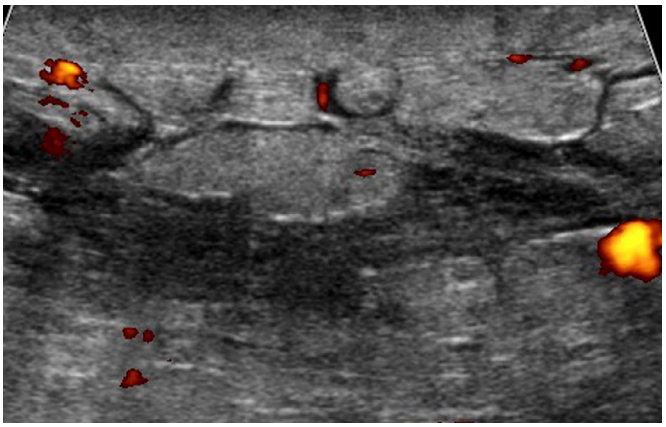


Figure 1: Hyperechoic Breast Parenchyma Demonstrating Extensive Subcutaneous Oedema.

(Figure 2a). Enlarged benign reactive lymph nodes are usually associated with uniform thickening of the cortices and with preservation of the fatty hilum, whereas metastatically involved lymph nodes usually exhibit irregular cortical thickening and with loss or replacement of the fatty hilum (Figures 2b,c).

Infectious mastitis

Infectious mastitis can be considered as lactational (puerperal) mastitis or non-lactational mastitis.

Lactational or puerperal mastitis

An infective mastitis that occurs in relation to lactation usually occurs as a result of milk stasis complicated by a superimposed bacterial infection. This is often *staphylococcus aureus* or *streptococcus sp*.; however, anaerobic bacteria such as *Bacteriodes* are not infrequently implicated.[5] In the early phases, this presents

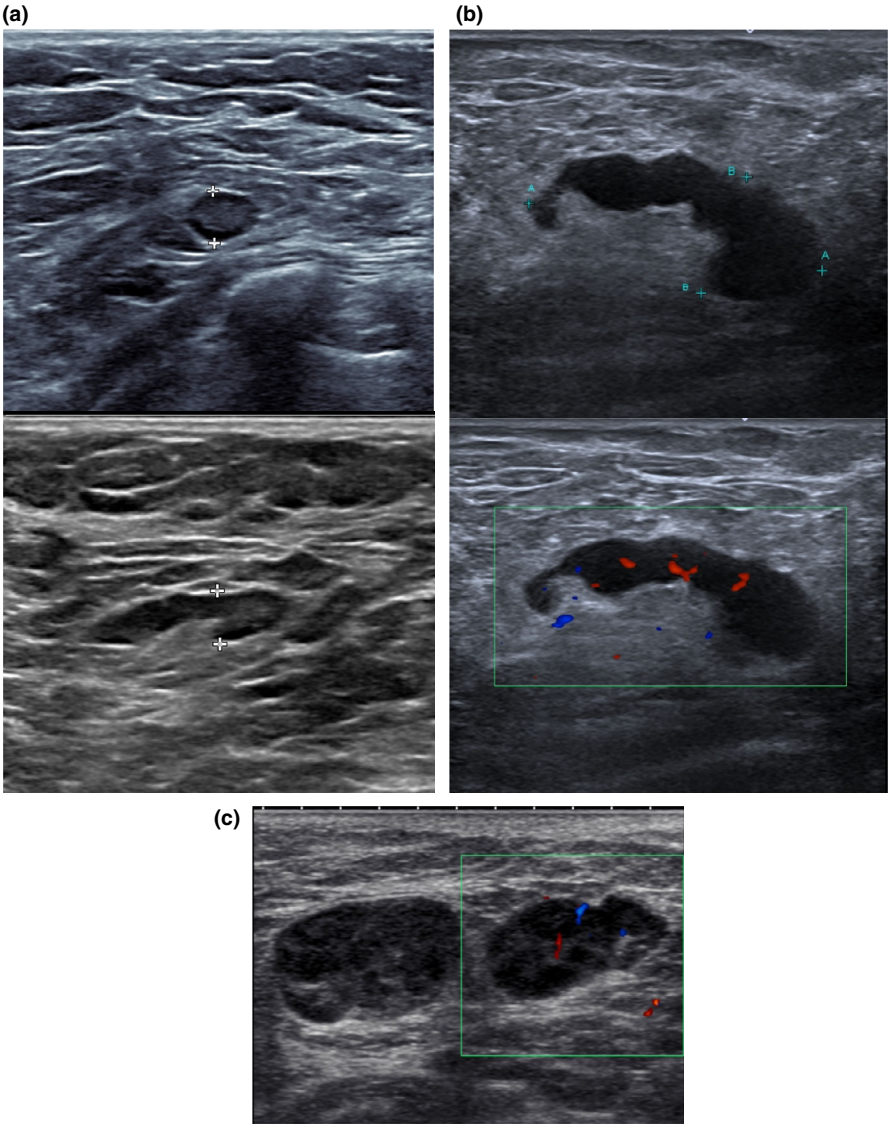


Figure 2: (a) Normal Lymph Nodes Showing Preservation of Hilum, Normal Cortex and Echogenicity. (b) Pathological Axillary Lymphadenopathy. The Lymph Node is Enlarged and the Cortex is Thickened and Asymmetric. (c) Pathological Lymph Nodes which have been Completely Effaced by Metastatic Malignancy with Obliteration of the Hilum.

as a cellulitis of the breast, which in some may progress to abscess formation.

Infective mastitis can also be the result of relatively rare infections such as Nocardia, a bacteria usually found in soil and water, *Pseudomonas aeruginosa* and fungi.[3]

The ultrasound findings in relation to an infective mastitis may be those of hyperaemia with increased vascularity seen on colour Doppler, and oedema of the tissues resulting in increased echogenicity throughout those affected segments of the breast. With progression to abscess formation, ultrasound may show evidence of a fluid collection appearing as an irregular hypoechoic area with heterogeneous internal echoes and a thickened wall. Posterior acoustic enhancement is present, and there is typically vascularity around but not within the mass. Tenderness to probe pressure is common, and axillary lymph nodes may be enlarged[6] (Figures 3–5).

With the aid of ultrasound guidance, the majority of abscesses can now be very successfully managed by repeated needle aspirations under antibiotic cover, as an alternative to open surgical drainage.[7] Antibiotic therapy would usually be provided with Flucloxacillin plus Metronidazole or Amoxicillin–Clavulanate. Pus can be aspirated from the abscess under ultrasound vision, and this may need to be repeated every 2–3 days until no further fluid is obtained. Large bore (18G) needles are advantageous in these circumstances, and there have also been reports of the use of vacuum-assisted biopsy needles to drain abscess under ultrasound guidance.[8] This sonographically mediated type of needle intervention has the advantage that breastfeeding can usually continue unabated, whereas when surgical intervention is undertaken this often results in cessation of lactation as a consequence of post-operative pain.

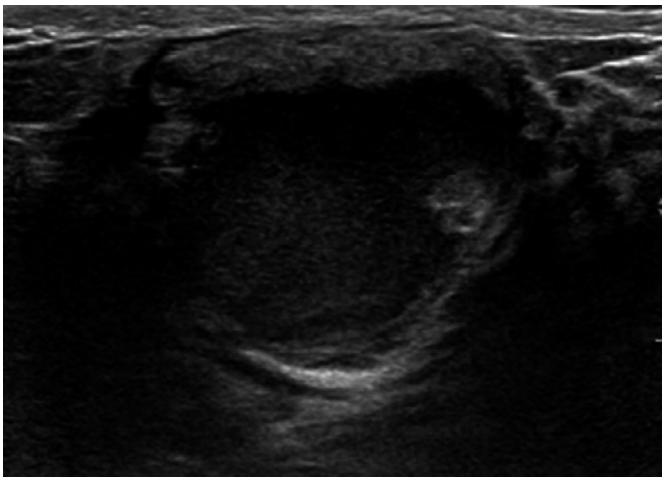


Figure 3: An Infected Galactocele Demonstrates a Well-Defined Border and a Rounded Mass with Homogenous Centre. There is Posterior Acoustic Enhancement with Tenderness to Probe Pressure. The Contents of a Galactocele are Usually more Homogenous than an Abscess.

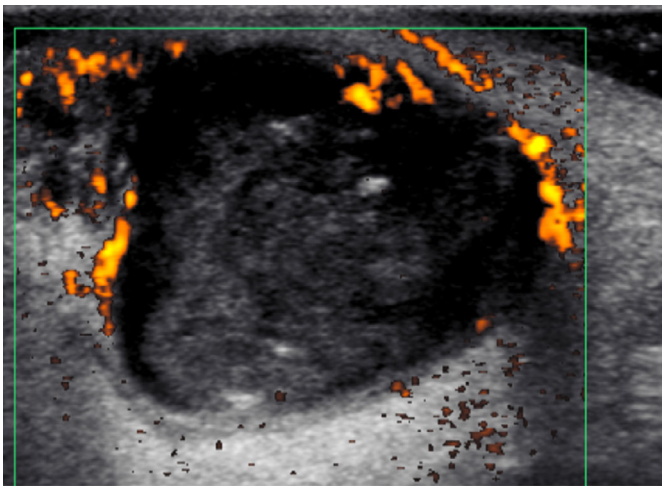


Figure 4: Lactational Abscess Demonstrating a Well-Circumscribed Border, Peripheral Increased Echogenicity, Increased Vascularity Surrounding the Mass and Internal Echoes within the Abscess Cavity.

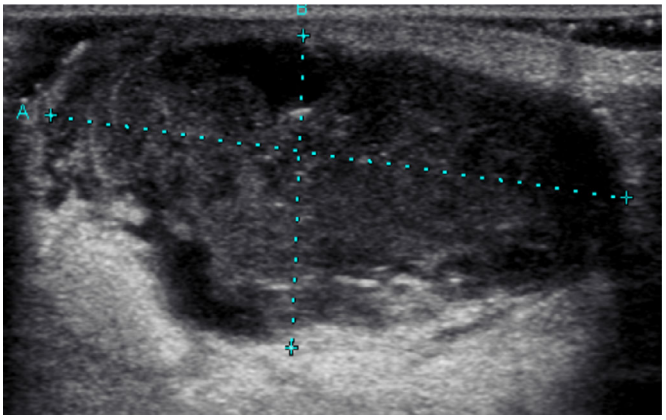


Figure 5: A Lactational Abscess with Oedema of Subcutaneous Tissues, Well-Circumscribed Borders, Internal Echoes and Increased Echogenicity Around the Periphery.

Non-lactational mastitis

Non-lactational infections can be considered in terms of those occurring centrally in the peri-areolar region, those occurring in the peripheral breast tissue and rarer types of infections.

Peri-areolar Infections. Peri-areolar infections are most commonly related to secondary bacterial infections of underlying duct disorders collectively grouped under the heading of periductal mastitis which will be described in more detail below. The entities of periductal mastitis (also known as plasma cell mastitis) and mammary duct ectasia are thought to represent a spectrum of the same auto-immune disease process with the former condition seen in younger women and the

latter seen in older women. The end result is duct blockage and/or dilatation which can predispose to secondary infection resulting in cellulitis, possible abscess development and occasionally mammary duct fistula formation.[1,9]

Ultrasound may demonstrate evidence of duct dilatation, and subareolar inflammation progressing to abscess formation, with associated hypervascularity (Figure 6). Ultrasound may also show evidence of a fistulous tract leading onto the skin.

Within the nipple–areola complex (NAC), there are numerous apocrine glands such as sebaceous (or Montgomery) and sweat glands, which potentially can become infected and present as an abscess arising from within the skin over the NAC. Ultrasound under these circumstances will see evidence of a small fluid collection abutting the skin in the subcutaneous plane. The majority of these superficial infections settle with oral antibiotics but occasionally surgical drainage is required.

Peripheral non-lactational breast abscesses. Classically, peripheral non-lactational breast abscesses tend to occur in older women and may be associated with a variety of underlying disease states such as diabetes, rheumatoid arthritis, steroid treatment or drug addiction.[2] The ultrasonic findings are the same as for other breast abscesses and management again is with aspirational drainage under ultrasound guidance (Figures 7, 8).

Occasionally, a peripheral breast cyst may become infected with the ultrasound features demonstrating an apparent cystic appearing lesion with well-defined margins but containing internal echoes suggesting the presence of debris or early abscess formation. Once again treatment with aspiration and antibiotics is recommended.

Rarer infections. Tuberculosis (TB) of the breast is a rare condition in developed countries; however, it should be considered in the differential diagnosis in our increasingly diverse population, particularly in women from areas where TB is endemic. Tuberculosis of the breast is typically secondary (from the lungs) but can be a primary affliction of the breast. Secondary TB is usually transmitted via haematogenous spread, although lymphatic spread represents another portal. It is often misdiagnosed as an abscess or as carcinoma due to the size, firmness and fixation of the mass. It is found in nodular, diffuse and sclerosing forms.[10]

Clinically, TB appears similar to granulomatous mastitis. Examination findings reveal a mass with thickened skin, nipple retraction, multiple sinus tracts and axillary lymphadenopathy. Masses are typically located in the central or upper outer quadrant of the breast. It may be present for months to years. Serum inflammatory markers are usually normal. The patient may or may not have constitutional symptoms of TB (malaise, pyrexia and night sweats). The tuberculosis mass is frequently fixated to the skin and/or chest wall[11] and can therefore be confused with inflammatory breast cancer.

Marinopoulos and Akcay[8] describe the classical appearance of an ill-defined and irregular marginated mass. It is typically hypoechoic. There may be sinus tract connecting to a localised area of thickened skin. Axillary lymphadenopathy is seen in approximately 50% of cases.. Diagnosis is confirmed with AFB-positive stain or PCR. A high index of suspicion is required as FNA is often non-diagnostic and CXR normal. Core or open surgical biopsy is recommended for definitive diagnosis.

Non-infectious causes of mastitis

Periductal mastitis, plasma cell mastitis and mammary duct ectasia. The above entities most probably represent a continuum of the same underlying condition.

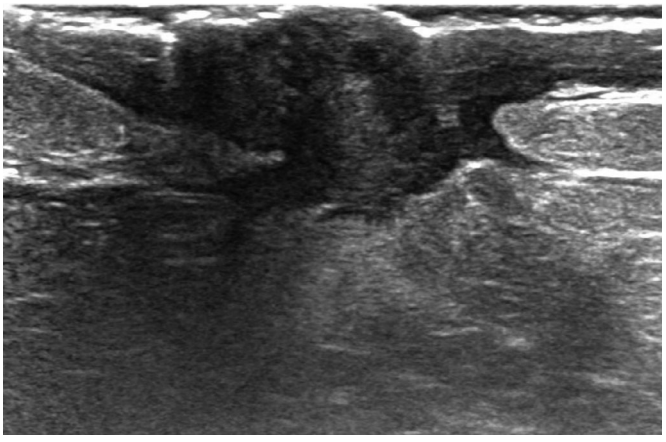


Figure 6: A Non-Lactational Abscess Deep to Nipple–Areolar Complex Demonstrating an Irregular but Distinct Border, a Hypoechoic Centre, Internal Echoes, Peripheral Enhancement and the Appearance of the Abscess Tracking within the Breast Parenchymal Planes.

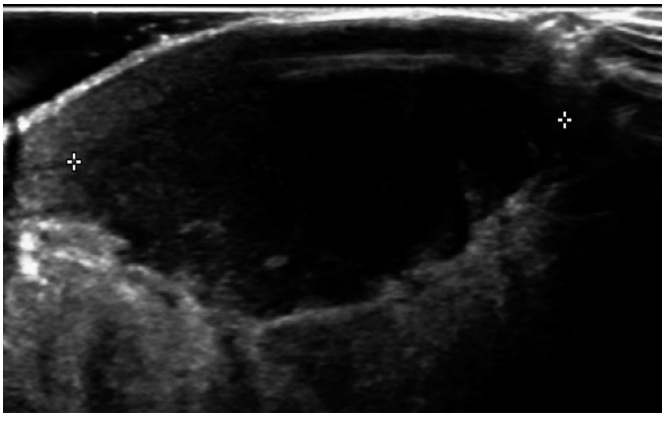


Figure 7: Peripheral Non-Lactational Abscess. A Well-Defined Thick Border with Increased Echogenicity Around but not within the Lesion. The Suppurative Contents Give Rise to Internal Echoes.

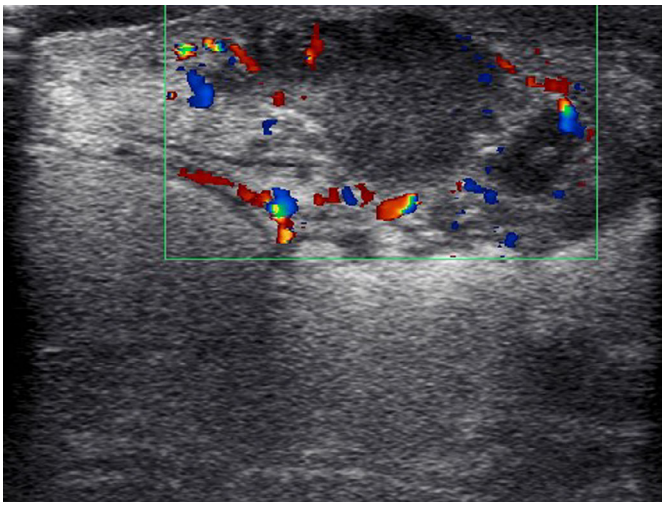


Figure 8: A Peripheral Non-Lactational Abscess Demonstrating Increased Vascularity Around the Abscess Cavity, Posterior Acoustic Enhancement and Enhancement at the Edge of the Abscess.

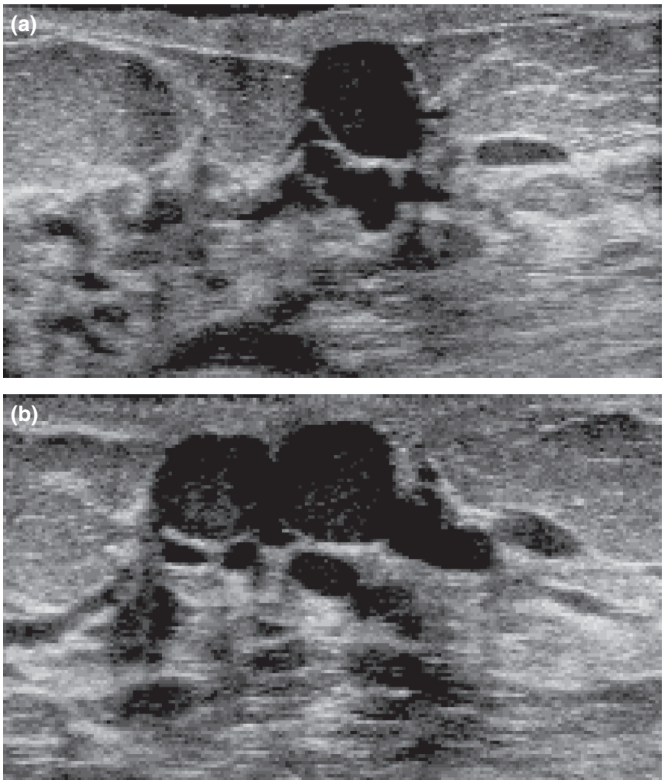


Figure 9: (a) and (b) Duct Ectasia Demonstrating Markedly Dilated Ducts in the Retroareolar Region.

The condition of periductal mastitis is usually seen in younger women with the average age being 32 years, and there is a frequent association with tobacco smoking.[12] The condition often presents with pain and discomfort around the nipple region,

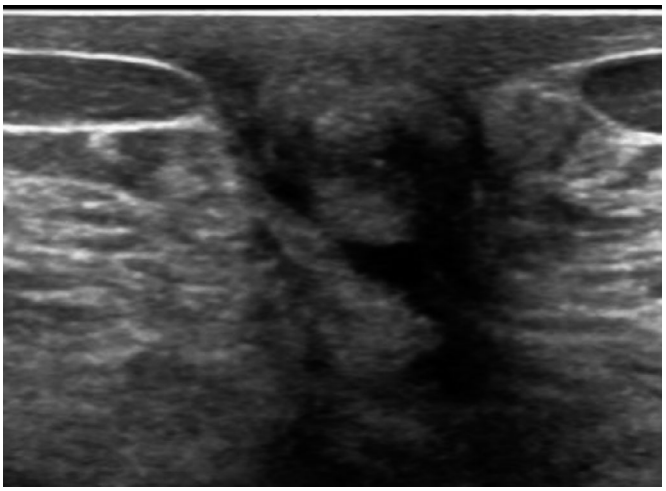


Figure 10: Periductal Mastitis Demonstrating a Hypoechoic Focus Directly Below the Inverted Nipple–Areolar Complex.

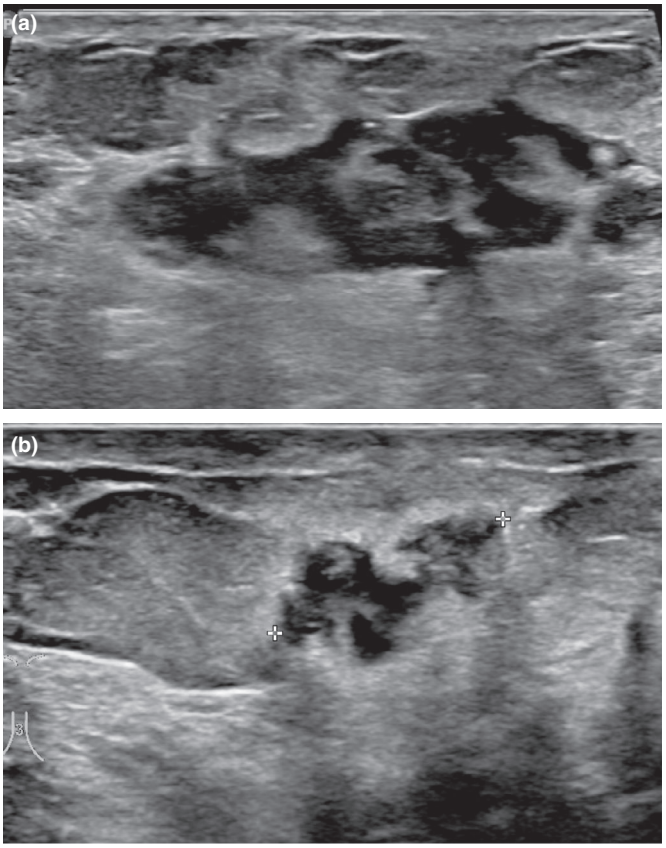


Figure 11: (a) and (b) Granulomatous Mastitis with an Irregular-Shaped Border, Multiloculated Appearance, Hypoechoic Centre, the Peripheral Enhancement is Less Pronounced than a Non-Lactational Abscess.

and there may be symptoms of a lump or nipple discharge. As the condition progresses, there may be secondary infection resulting in abscess formation or fistulous tract development.

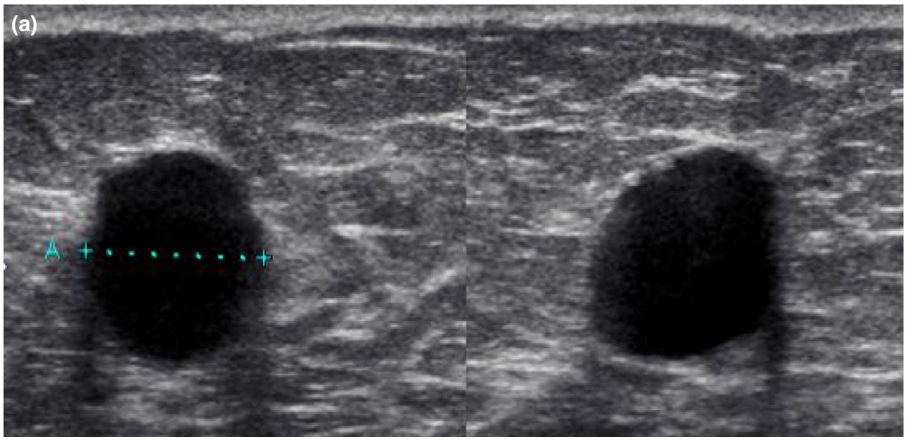
Figure 12: Granulomatous Mastitis Demonstrating Sinus Tracts and Widespread Oedema of Tissues.

Mammary duct ectasia occurs in older women, primarily in the peri-menopausal and post-menopausal age group and is characterised by dilatation of the subareolar ducts which is often associated clinically with nipple discharge or nipple retraction. Controversy surrounds the underlying aetiology of this condition, and although periductal inflammation in the form of plasma cell mastitis is usually seen, it is unclear as to whether the inflammation is the primary event causing breakdown of the duct wall with subsequent dilatation, or whether the inflammation is a result of rupture of the ectatic ducts.[12]

The ultrasound features of this condition, as described earlier, demonstrate dilated ducts in the subareolar region, often with intraluminal debris identified and with associated increased echogenicity of the duct walls. Increased colour Doppler flow is usually seen in the periductal breast tissue.[9] (Figure 9a,b). Ultrasound examination of periductal mastitis as seen in younger women often simply shows marked hypoechogenicity deep to the nipple indicative of duct inflammation and thickening (Figure 10).

Long-standing duct ectasia can be associated with calcified plugs in the duct lumens which are often linear and sometimes branching, and will be demonstrated on ultrasound as multiple areas of calcification associated with shadowing.

Granulomatous mastitis. Granulomatous mastitis is a mass-forming idiopathic inflammatory condition of the breast



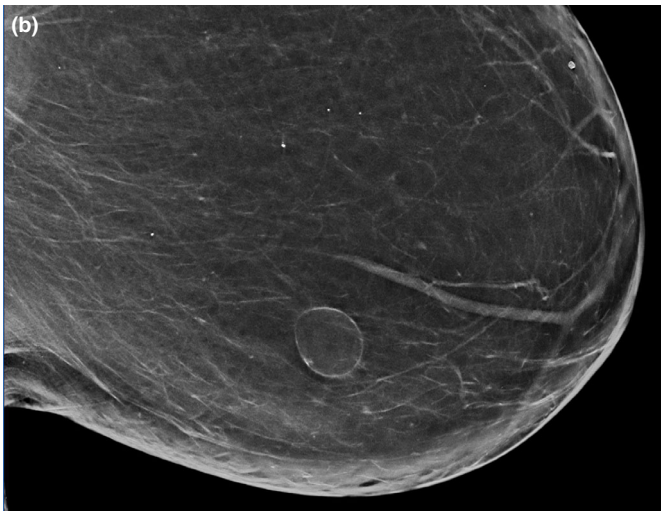


Figure 13: (a) Fat Necrosis Following a Seatbelt Injury to the Left Breast, Showing a Well-Defined Oil Cyst. There are Well-Circumscribed Borders and a Hypoechoic Centre. (b) Mammography Demonstrating the Oil Cyst in the Same Patient.

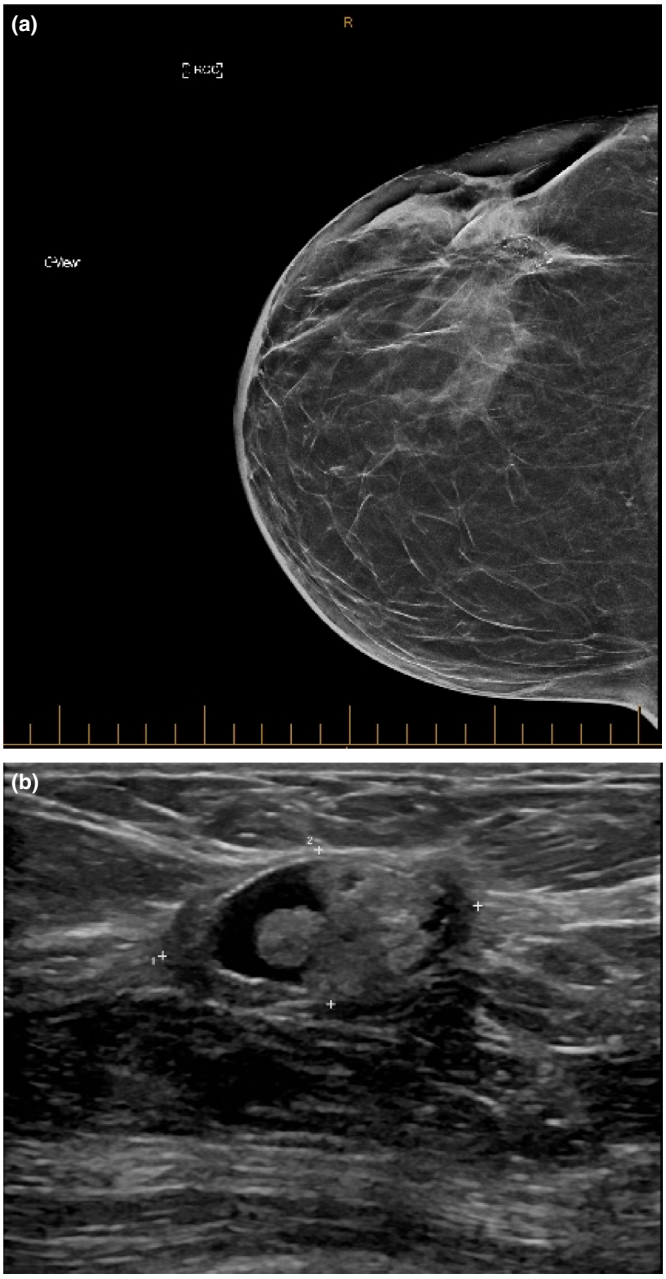


Figure 14: (a) Mammogram Showing Fat Necrosis and Oil Cyst Formation Following Lumpectomy and Radiotherapy Treatments Lateral Right Breast for Early Breast Cancer. (b) Ultrasound of Same Patient as (a) Demonstrating Oil Cyst with Calcification in Wall and Associated Necrotic Fatty Tissue.

usually seen in young women. Although its aetiology is unknown and has conventionally been considered to represent an auto-immune condition (associated with connective tissue disorders and sarcoidosis),[9] it has recently been linked to a number of infective agents including *Corynebacteria* infections.[13] Interestingly, granulomatous mastitis classically

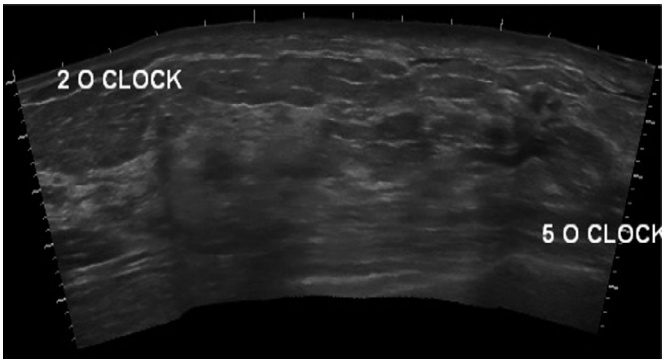


Figure 15: Inflammatory Breast Cancer Demonstrating Extensive Subcutaneous Oedema of the Skin and Subdermal Layers. There are Two Ill-Defined Foci of within the Image. The Lesions Have Indistinct Borders, are Hypoechoic and Ill-Defined. Oedema of the Prepectoral Plane is Also Seen.

presents approximately 2 years following breastfeeding. Patients may receive multiple courses of antibiotics with little or no response to these treatments. If *Corynebacteria* are suspected tetracycline antibiotic therapy is recommended.

Women are usually systemically well but present with a firm breast mass that has often been present for months. There may or may not be associated erythema, and the mass is typically painful with signs of local inflammation. There may be sinus tracts, but these are less frequent than in the context of TB. Axillary lymphadenopathy is variably present. Prior biopsies or abscesses drainage procedures may complicate imaging.

Ultrasound reveals a lesion with a border which is irregular, lobulated or has finger-like projections.[14,15] The mass is heterogeneously hypoechoic and may have the appearance of multiple abscesses. (Figures 11 and 12). Most masses are located in the peripheral breast. Fistulation, skin thickening, skin retraction, axillary lymphadenopathy and dilated ducts can be seen. Less common ultrasound features include diffuse increased parenchymal density only with no discrete mass, and with associated parenchymal distortion and posterior acoustic shadowing.[14] Diagnosis is made on histology showing lobulo-centric non-necrotising granulomas and microabscess.[15]

Fat necrosis. The importance of fat necrosis lies in the fact that it may closely simulate carcinoma both clinically and on imaging.

Fat necrosis is the result of trauma to the lipomatous tissues of the breast. Saponification from sterile autolysis occurs resulting in, at a cellular level, the infiltration of foamy macrophages and giant cells.[15] The initial insult may be trauma, surgery or radiotherapy.

Clinically, this presents as a firm lump, which is typically small, hard and non-tender, with no overlying signs of skin involvement, and axillary lymphadenopathy is usually absent. Typically, the palpable lump is adjacent to, or near surgical incisions.

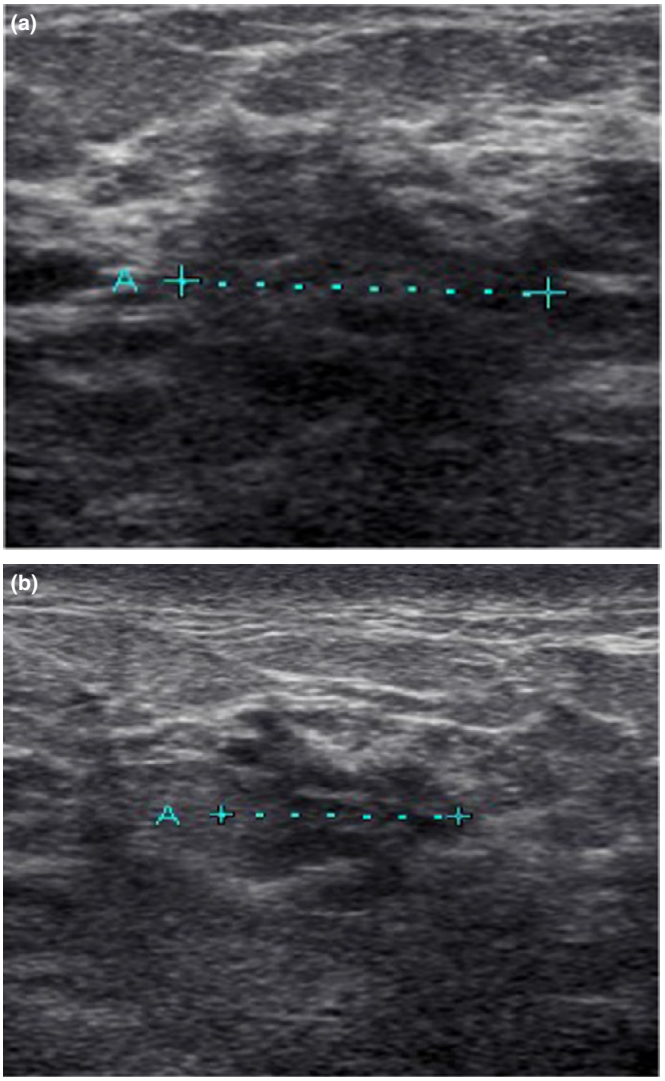


Figure 16: (a) and (b) Both Images are of an Inflammatory Breast Cancer Demonstrating Focal Mass Lesions. Note the Indistinct Borders of the Hypoechoic Masses with Oedema of Surrounding Tissues Recognised by the Increased Enhancement. (b) The Same Inflammatory Carcinoma as (a) in a Different Plane.

On ultrasound, the characteristics of fat necrosis depend on the stage of evolution of the pathology. In the early phase, there may be haemorrhage and oedema of the fatty tissues of the breast resulting in an area of increased echogenicity. If resolution is slow to occur, oil cyst formation may develop over the ensuing months which appears as a hypoechoic cyst and which not infrequently develops calcification within its wall resulting in shadowing (Figures 13 and 14). Fat necrosis even without oil cyst formation often becomes cicatrised and may in the latter stages mimic malignancy appearing as an irregular hypoechoic lesion associated with shadowing. Often as core biopsy is required to make a definitive diagnosis.[15]

Inflammatory breast carcinoma

Inflammatory breast carcinoma is an aggressive form of invasive cancer characterised by diffuse infiltration of breast tissue with both lymphatic and dermal involvement. This presentation of breast cancer is characterised by sudden onset of symptoms with the time interval from the onset of symptoms to diagnosis usually being within 3 months. Patients present with localised or diffuse erythema of the skin over the breast, and there is often an associated palpable mass which is variably tender. The classically described oedema of the skin (peau d'orange) results from a combination of obstructed dermal lymphatics within the breast and axillary lymph nodes congested by metastatic tumour deposits. Inflammatory breast malignancy however may be less tender and show more diffuse lymphatic engorgement than most infective conditions.

In inflammatory breast carcinoma, ultrasound will demonstrate dermal thickening and oedema, and often small anechoic areas may be seen within the dermis representing dilated dermal lymphatics.[3,5] Ultrasound may also demonstrate an increase in the echogenicity of the breast parenchyma related to oedema of the tissues and thickened Coopers ligaments and will often also reveal multiple suspicious hypoechoic tumour masses with posterior acoustic shadowing and irregular borders (Figures 15 and 16). There may also be microcalcifications identified with any mass lesion.[5] Doppler will demonstrate increased vascularity throughout the tissues and oedema of the prepectoral plane may be identified. There may also be enlarged axillary lymph nodes seen with irregular cortical thickening, evidence of metastatic involvement. It can be a challenge to differentiate inflammatory breast cancer from benign inflammatory processes. Important clues are the increased internal vascularity, the presence of specific hypoechoic densities associated with shadowing and the marked degree of parenchymal heterogeneity associated with inflammatory breast cancer.

Conclusion

Ultrasound is an indispensable imaging tool in the assessment and management of inflammatory conditions of the breast, and particularly as many of these patients will be of a younger age group with dense breast parenchyma, with mammography being of limited utility. The essential paradigm in the management of breast inflammation is that in the event of a 'mastitis' failing to respond to antibiotic therapy, the possibility of inflammatory breast cancer needs to be contemplated.

Conflict of interest

The authors have no conflicts of interest to declare and were not recipients of research funding relevant to this study. The authors are in agreement with the contents of the manuscript.

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