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Original Article

Imaging enigma in mastitis: A comprehensive study of multifaceted causes, clinical and radiological presentations

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ABSTRACT

Background: Mastitis is an inflammatory condition of the breast which represents an array of underlying etiologies encompassing both infectious and non-infectious causes. Exacerbating factors include endemic infections, lack of awareness and suboptimal breastfeeding practices. Neglected cases lead to prolonged morbidity, recurrent episodes, and complications such as abscess or sinus formation, resulting in permanent breast disfigurement. Its overlapping clinical presentation with breast cancer necessitates an integrated multidisciplinary approach for diagnosis and treatment.

Objectives: The primary aim was to investigate demographic, radiological, and histopathological characteristics of mastitis. Objectives included correlating radiological and histopathological findings, classifying mastitis by etiology, identifying the clinical and imaging patterns across diverse clinical settings to enhance the understanding of mastitis.

Material and method: This is a retrospective observational study, analysing the clinical, radiological, and histopathological data from 65 patients with mastitis between February 2023 and February 2024.

Results: The study included 65 patients, aged 18 to 65 years, with breast pain as the most prevalent clinical presentation. Cases were classified as infectious (47.6%) and non-infectious (52%). Acute puerperal mastitis (26.15%) and granulomatous mastitis (30%) were the most common subtypes. The commonest mammographic finding was focal asymmetry. On ultrasound, infectious mastitis showed oedema with other inflammatory changes, including diffuse skin thickening and collections; while non-infectious mastitis typically presented as solitary or multiple breast masses ($p < 0.001$). Surprisingly, idiopathic granulomatous mastitis constituted the largest percentage amongst various histopathological causes of mastitis in our study.

Conclusion: An integrated multidisciplinary approach with understanding of the pathogenesis is imperative for prompt diagnosis and optimizing treatment strategies, thereby improving patient outcome. Radiological imaging is critical for diagnosis, evaluating disease extent, conducting guided interventions, and monitoring treatment response.

Introduction

Mastitis is an inflammatory condition of the breast, encompassing various infectious as well as non-infectious etiologies, primarily affecting women of childbearing age. Key risk factors include lactation, immunocompromised status, oral contraceptive pills, and smoking.[1-3] Infectious mastitis can be bacterial, tuberculous, parasitic, and even fungal, while non-infectious mastitis can be inflammatory, immunological, or vascular.[4] Granulomatous mastitis (GM) is a distinct non-infectious subtype, which often mimics breast cancer. Accurate diagnosis, essential for optimum treatment, requires a comprehensive integrated approach involving radiological imaging, clinical assessment,

Abbreviations: GM, Granulomatous mastitis; US, Ultrasound; CNB, core needle biopsy; FNA, fine needle aspiration cytology; CT, Computed Tomography; MRI, Magnetic Resonance Imaging; IGM, Idiopathic granulomatous mastitis; ZN, Zeihl Neelsen; GMH, Grocott's methenamine silver; TM, Tuberculous mastitis; DM, Diabetic Mastopathy.

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Table 1
Chief presenting symptoms of patients.

Presenting complaint	Percentage	Frequency(n)
Breast pain	92.8%	60
Palpable Lump	76.9%	50
Erythema	46.2%	30
Skin discharging sinus	17%	11
Nipple discharge	4.6%	3
Nipple retraction.	6%	4
Palpable axillary lymph nodes	43%	28

Table 2
Ultrasonography findings in 65 patients with symptoms of mastitis.

Sonographic Findings	**Frequency (n)**	**Percentage (%)**
Parenchymal oedema	47	72.3
Raised parenchymal vascularity on colour doppler	42	64.6
Skin thickening	39	60
Abscess	32	49.2
Mass	26	40
Dilated subareolar lactiferous ducts	24	36.9
Diffusely heterogeneous parenchyma with no discrete mass	7	10
Sinus tracts	11	16.9
Axillary lymph nodes with increased cortical thickness (>3mm) / short axis diameter (>15mm)	39	60
Axillary lymph nodes Loss of fatty hilum	3	4.6

Table 3
Mammographic findings in 40 patients.

Mammographic Finding	**Frequency (n)**	**Percentage (%)**
Focal asymmetry	24	60%
Skin Thickening	20	44%
Solitary/multiple masses	11	27.5%
Presence of calcifications	10	25%
Global asymmetry	5	12.5%
Nipple retraction	3	7%
Axillary Lymphadenopathy	17	67.5%

Table 4
Ultrasonography and mammographic findings in patients with IGM.

Ultrasound Features	**Frequency (n)**	**Percentage (%)**
Hypoechoic irregular mass with tubular extensions insinuating into adjacent breast tissue	12	60 %
Skin thickening	10	50 %
Parenchymal oedema	8	40 %
Heterogeneous parenchyma with no discrete mass	4	20 %
Abscess and/or sinus tract	3	15 %
Well circumscribed oval hypoechoic mass	1	5 %
Axillary lymphadenopathy	11	55 %
Mammographic Findings	**Frequency (n)**	**Percentage (%)**
Focal asymmetry	9	50 %
Skin Thickening	5	27%
Irregular Mass	6	33 %
Global asymmetry	3	16 %
Axillary lymphadenopathy	10	56 %

and histopathological analysis. While ultrasound (US) is the primary diagnostic tool, non-resolving cases require biopsy to identify the cause and to exclude malignancy.[5,6] Despite its high prevalence, the existing literature on clinical-radiological presentation and management protocols is limited. This study aims to review the diverse causes of mastitis, identify various histopathological subtypes, and highlight the key clinical and radiological features.

Table 5
Various histopathological subtypes of mastitis.

Infectious Mastitis	**Frequency**
Acute Puerperal mastitis	26.15% (n=17)
Tuberculous mastitis	7.6%(n=5)
Non-Puerperal subareolar mastitis	3.1%(n=2)
Non-Puerperal peripheral mastitis	3.1%(n=2)
Post procedural/operative collection	3.1%(n=2)
Infected galactocele	1.6%(n=1)
Filariasis	1.6%(n=1)
Breast Cysticercosis	1.6%(n=1)
Fungal	1.6%(n=1)
Infected epidermoid cyst	1.6%(n=1)
Non-Infectious Mastitis	
Idiopathic Granulomatous mastitis	30%(n=20)
Plasma cell mastitis /Periductal mastitis	4.6%(n=3)
Collagen vascular disorder	3.1%(n=2)
Inflammatory breast carcinoma	3.1%(n=2)
Diabetic mastopathy	1.6%(n=1)
Xanthogranulomatous mastitis	1.6%(n=1)
Panniculitis	1.6%(n=1)
Neurofibromatosis	1.6%(n=1)
Fat necrosis	1.6%(n=1)

Table 6
Correlation of breast ultrasonography findings in the infectious and non-infectious group of mastitis.

Ultrasound Findings	Infectious Mastitis	Non-infectious mastitis	P value
Abscess	26	6	<0.001*
Mass	5	21	<0.001*
Parenchymal Oedema	26	21	<0.306
Skin Thickening	27	12	0.289
Dilated Subareolar Lactiferous Ducts	18	6	0.005*
Sinus Tracts	9	2	0.009
Axillary lymph nodes with increased cortical thickness(>3mm)/short axis diameter(>15mm)	21	18	0.480
Axillary lymph nodes Loss of fatty hilum	2	1	0.535

Materials and method

In this retrospective observational study, the data from 65 patients diagnosed with mastitis was collected from the radiology, surgery, and pathology departments from February 2023 to February 2024. Imaging data was obtained for all patients with sonography examinations and/or mammography followed by ultrasound-guided core needle biopsy (CNB) or fine needle aspiration cytology (FNA) of breast masses or abnormal axillary lymph nodes. Informed consent was waived due to study's retrospective nature. Demographic data (age, sex), previous family history of cancer, clinical presentations, and radiological investigations (ultrasound [US], mammography, Computed Tomography [CT] and Magnetic Resonance Imaging [MRI]) were reviewed. Subtypes were classified based on aetiologies, and key clinical and radiological features were noted.

Results

Demographic data and clinical complaints

The study population included 65 patients (63 females and 2 males), with mean age of 34.8 years (range 18-65). Most females (87.3%) were premenopausal/ perimenopausal and 12.7 % were post-menopausal. Two patients were pregnant. Post pregnancy presentation time varied - 15.8 % females presented within 6 months, 23.8% within 6 months to 1

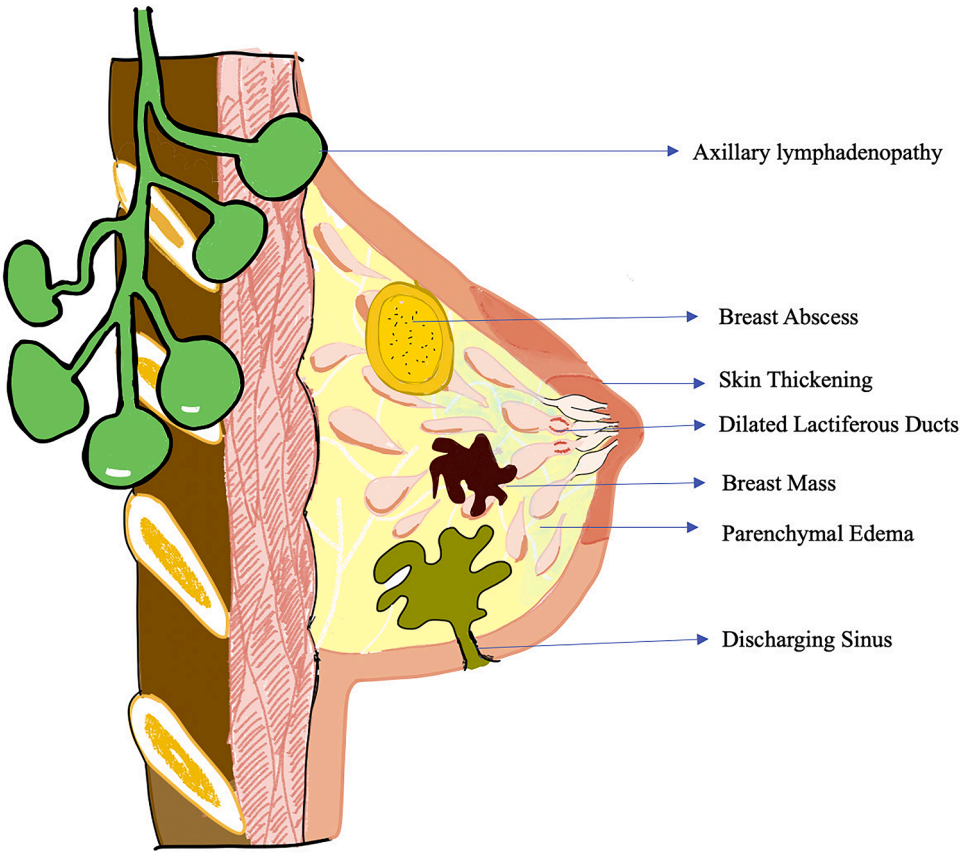

Fig. 1. Drawing depicting radiological findings in various subtypes of mastitis. Adapted and modified from Baykan AH et al..[49]

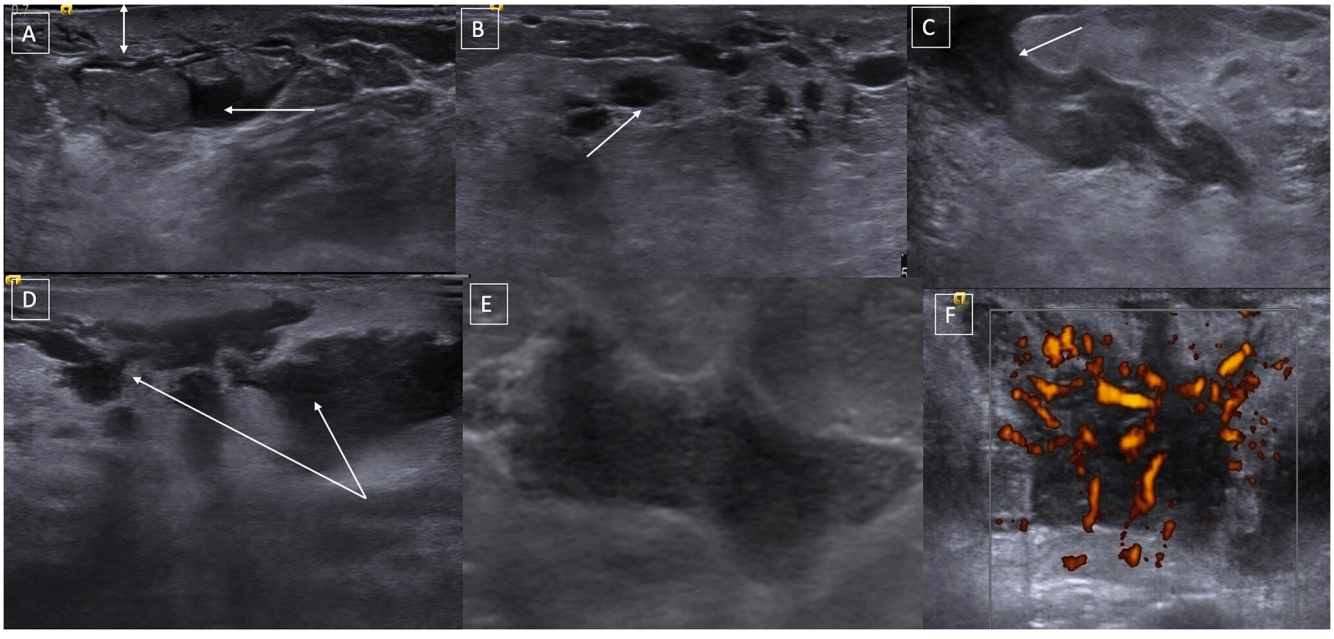

Fig. 2. Representative sonographic images of typical findings of mastitis in different patients, illustrating various stages and features of this condition (A) Skin thickening (double headed arrow) with anechoic fluid in subcutaneous fat consistent with edema (arrow), (B) Dilated subareolar lactiferous ducts, (C) Sinus tract extending to skin, (D) Multiple pockets of collection, (E) Irregular hypoechoic mass, (F) Raised vascularity on color doppler.

year, 39.6% within 1 to 5 years, and 20.6% after 5 years. Breast pain was the most common clinical presentation. (Table 1) Family history of breast cancer was noted in 3 patients, breast trauma in 4, smoking in 1 and diabetes in 6 patients. Eight patients used oral contraceptive pills. Most were managed with antibiotics and steroids, while 7 with non-resolving mastitis underwent surgical incision and drainage.

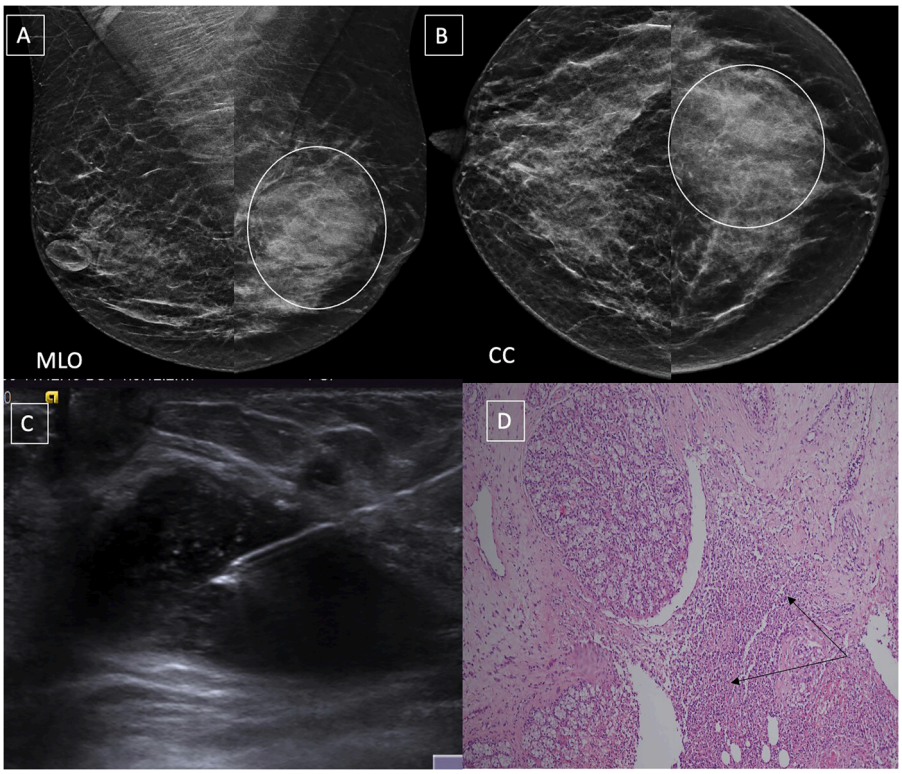

Fig. 3. A 36-year lactating mother with painful breast lump. (A, B) Mammogram showing partially obscured, equal density mass in lateral-central left breast. (C) Ultrasound image depicts irregular collection with internal echoes with aspiration needle in situ. Pus was aspirated using 18-guage needle from this collection. (D) Photomicrograph showing dense neutrophilic infiltrate (black arrow) indicative of acute mastitis and periphery shows breast parenchyma with lactational changes.

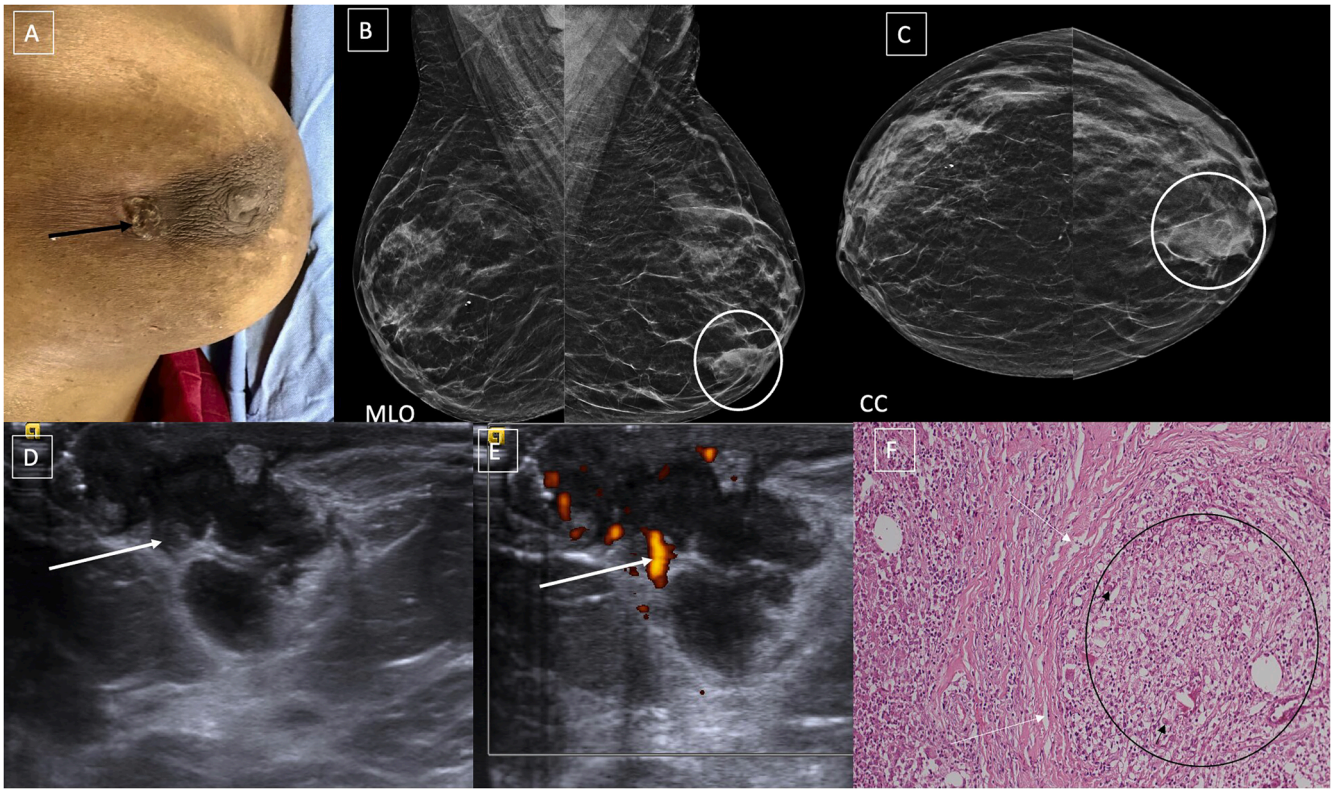

Fig. 4. (A) A 49-year-old female who was a smoker, presented with breast pain and discharging peri areolar sinus. (B,C) Mammography reveals irregular, partially indistinct equal density mass in peri and retro areolar location. (D,E) On ultrasound image, ill-defined collection extending to skin surface with raised perilesional vascularity is noted. (F) Pus was retrieved on aspiration with 18-gauge needle. Photomicrograph showing dense neutrophilic infiltrate along with macrophages (black arrows) and fibrosis (white arrows); as evidence of organization, consistent with organized abscess (Zuska's disease) (H&E, x200).

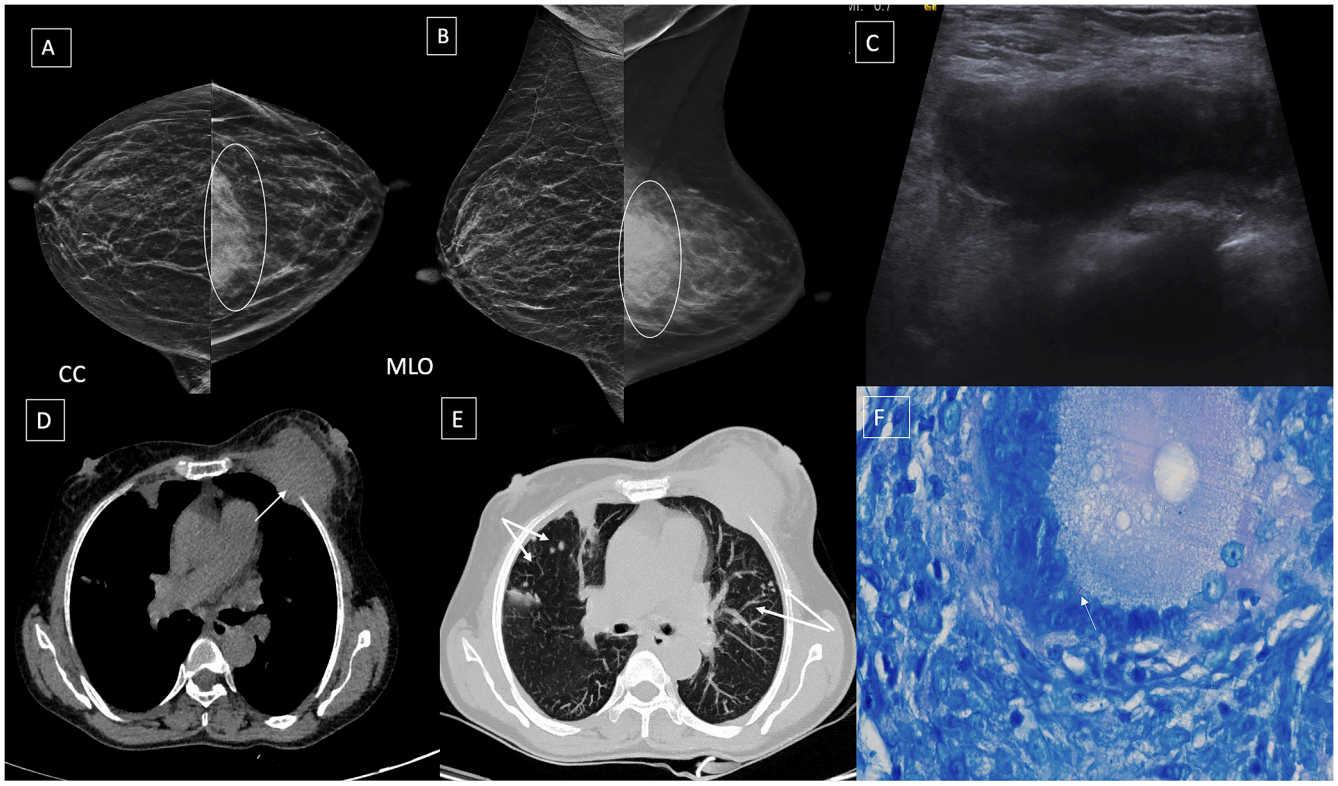

Fig. 5. 35-year-old female came with left breast pain and enlargement (A, B) Craniocaudal and mediolateral oblique mammography images depict a high-density mass in the posterior one-third of left breast. (C) Ultrasound revealed a large anechoic collection in the posterior-third of left breast. (D) Axial CT image illustrates a large heterogeneous collection involving the posterior left breast as well as underlying chest wall (white arrow). (E) Centrilobular pulmonary nodules were seen on lung window (grouped arrows), (F) Ziehl Neelsen stain highlights occasional acid-fast bacilli (arrow) [ZN stain, x1000] in the aspirate from collection.

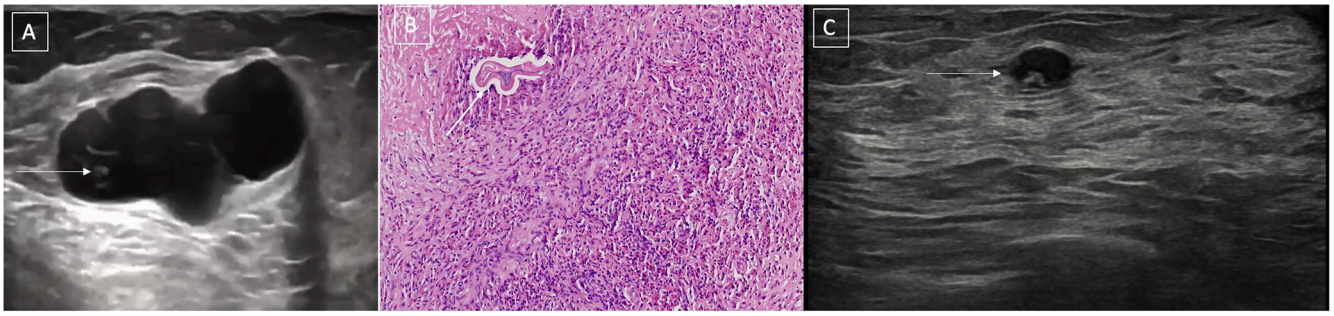

Fig. 6. A 26-year-old patient came with a palpable lump. (A) Ultrasound (US) images depicted a well circumscribed oval cystic lesion with mobile internal content (white arrow), giving the classical 'Filarial Dance Sign' (Supplementary Video), (B) Pathology was consistent with breast filariasis (arrow). The patient was put on diethylcarbamazine citrate and showed reduction in the size of the swelling after two weeks (C) US image in another young woman with a palpable superficial lump, depicting anechoic cyst with eccentric echogenic scolex consistent with breast cysticercosis. Patient responded well to albendazole 15 mg kg^{-1} twice daily in divided doses for two weeks.

Imaging findings

US findings were reviewed for all patients. Parenchymal oedema with increased surrounding echogenicity was the most common finding in 47 patients (72.3%). Skin thickening and dilated subareolar lactiferous ducts were seen in 39 (60%) and 24 (36.9%) patients, respectively. Solitary or multiple intercommunicating complex abscesses were present in 32 patients (49.2%), mostly in periareolar and retroareolar locations. Hypoechoic solitary or multiple masses were present in 26 patients (40%). Seven patients (10%) had diffusely heterogeneous parenchyma with no discrete collection or mass. The most common morphology was an irregular, hypoechoic mass with indistinct margins (Table 2). Mammographic imaging was available for 40 patients. It was not performed for remaining young (<30 years of age) or pregnant patients with no suspicious findings for malignancy, patients with extremely painful and those having tender breasts with discharging sinuses. Findings were categorized as global asymmetry, focal asymmetry, and solitary or multiple masses. Calcifications, skin thickening, nipple retraction, and lymphadenopathy were also evaluated (Table 3). Idiopathic granulomatous mastitis (IGM) was present in 30% (20 patients). US showed presence of an irregular hypoechoic mass with insinuating tubular extensions into the breast parenchyma in 60% patients with IGM. Four patients had parenchymal distortion without discernible mass, and only one had a well circumscribed oval hypoechoic mass. Focal asymmetry was the commonest mammography finding (Table 4). MRI records for two patients with recurrent mastitis showed skin thickening, peripherally enhancing micro abscesses, non-mass enhancement, and axillary lymphadenopathy. CT scans in two patients

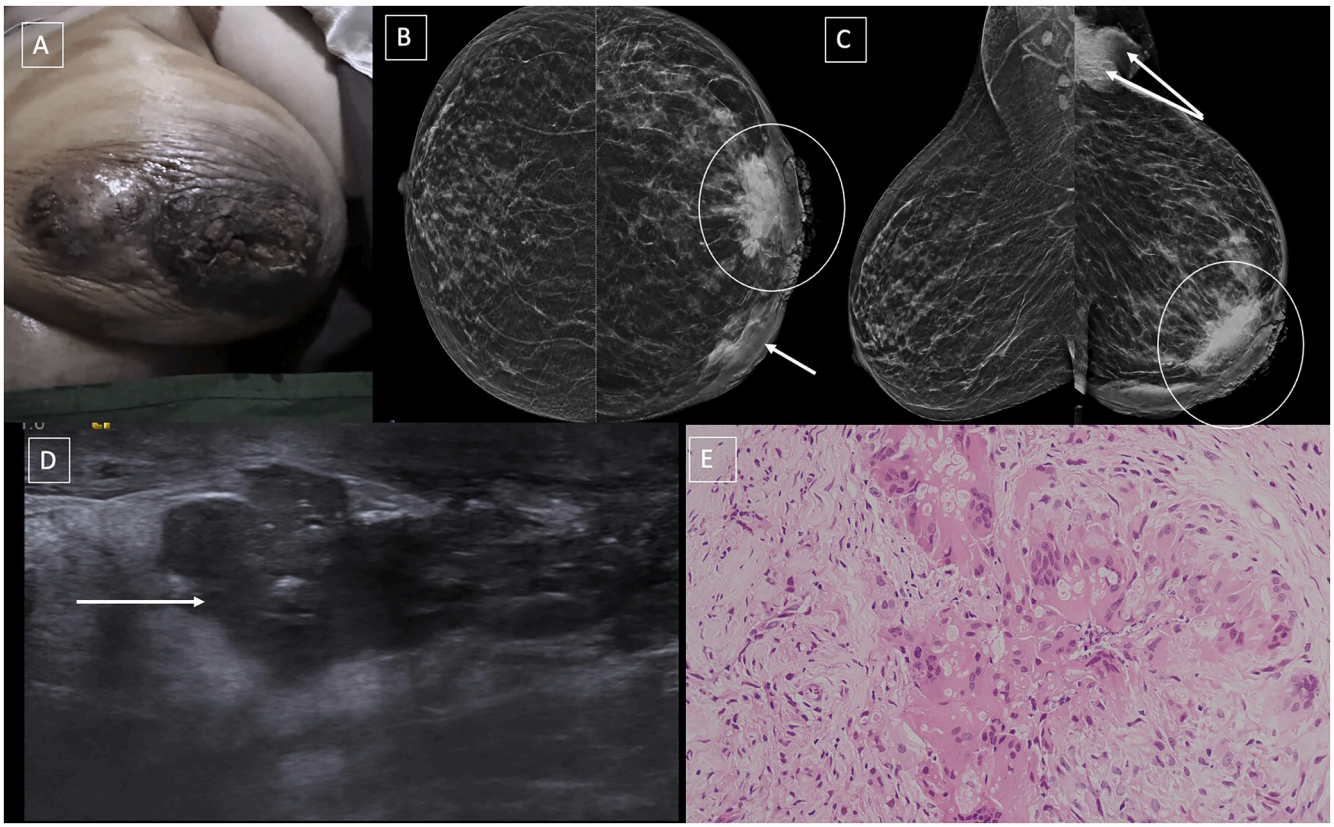

Fig. 7. (A) A 65-year-old female with uncontrolled type II diabetes mellitus complained of a large ulcerated skin lesion with a palpable lump in her left breast. (B,C) Craniocaudal (CC) and mediolateral oblique (MLO) mammography images show skin thickening (arrow) with an indistinct mass in the breast (circle), as well as enlarged axillary lymph nodes (grouped arrow). (D) Ultrasound [US] revealed presence of an irregular partially indistinct mass (white arrow) along with diffuse skin thickening and edema. (E) US-guided core needle biopsy was consistent with the diagnosis of fungal mastitis. Photomicrograph showing foreign body giant cells with fragmented septate fungal hyphae seen as negative shadows (H&E, x400).

with tuberculous mastitis revealed pulmonary tuberculosis findings and chest wall collections.

Histopathological evaluation

For breast abscesses, pus was aspirated for culture and smear. Core needle biopsy with 14 G gun was performed for a breast mass or patients with diffuse heterogeneous parenchyma without a discernible mass, with specimens sent for histological evaluation, tuberculous and fungal culture. Idiopathic granulomatous mastitis was diagnosed by the presence of non-caseating granulomas amid inflammation, with no specific cause. Special stains included Zeihl Neelsen (ZN) for tuberculous bacilli and Grocott's methenamine silver stain (GMH) for fungi. Common infectious subtypes included acute puerperal mastitis (26.5%), non-puerperal subareolar and peripheral mastitis, specific infections like tuberculosis or fungal mastitis as well as uncommon infections such as breast cysticercosis and filariasis. The non-infective subtypes encompassed idiopathic granulomatous mastitis (IGM), periductal or plasma cell mastitis, collagen vascular disorders (Dermatomyositis), panniculitis, diabetic mastopathy and three patients of malignant inflammatory breast carcinoma (Table 5).

Data analysis and interpretation

Sonographic and mammographic findings were reviewed and correlated with histopathological findings. Cases were classified as infectious (31; 47.6%) and non-infectious mastitis (34; 52%). Statistical analysis was performed using SPSS software, with data expressed as percentages and frequencies. Pearson Chi Square and Anova tests were used, considering p-value <0.05 as significant. Comparative analysis of infectious mastitis and non-infectious mastitis was done. Infectious mastitis occurred younger patients (mean age 32.6 years), while non-infectious mastitis had a mean age of 38.4 years. Breast abscesses, discharging sinuses, and dilated subareolar lactiferous ducts were more common in infectious mastitis ($p<0.001$). Solitary or multiple masses were more common in non-infectious mastitis ($p<0.001$) (Table 6).

Discussion

Imaging in mastitis serves diagnostic as well as therapeutic purposes. Ultrasound is the first modality providing prompt diagnosis and guiding therapeutic interventions with tolerable discomfort.[6] Mammography is often avoided due to dense breast tissue in younger patients and difficult compression of tender breast, it being generally used for cases with suspicion of underlying malignancy.[7,8,9] Contrast enhanced MRI helps in delineating extent of the disease and detecting underlying occult malignancy, however, it is primarily used as a problem-solving tool, not for initial diagnosis.[10-13] Despite being a potential cause of morbidity amongst women of all age groups, literature on mastitis is limited, and lacks comprehensive overview of the clinical, radiological, and histopathological findings. Our study provides clinical and imaging insights into the varied presentation and multifaceted causes of mastitis. We grouped the patients presenting with mastitis based on aetiology. The common ultrasound findings in patients with mastitis included the presence of skin thickening, parenchymal oedema, dilated subareolar lactiferous ducts, raised vascularity and presence of irregular collections/masses (Fig. 1,2). Our comparative findings of infectious and non-infectious mastitis corroborate with the study by Kamal et al.[2] The

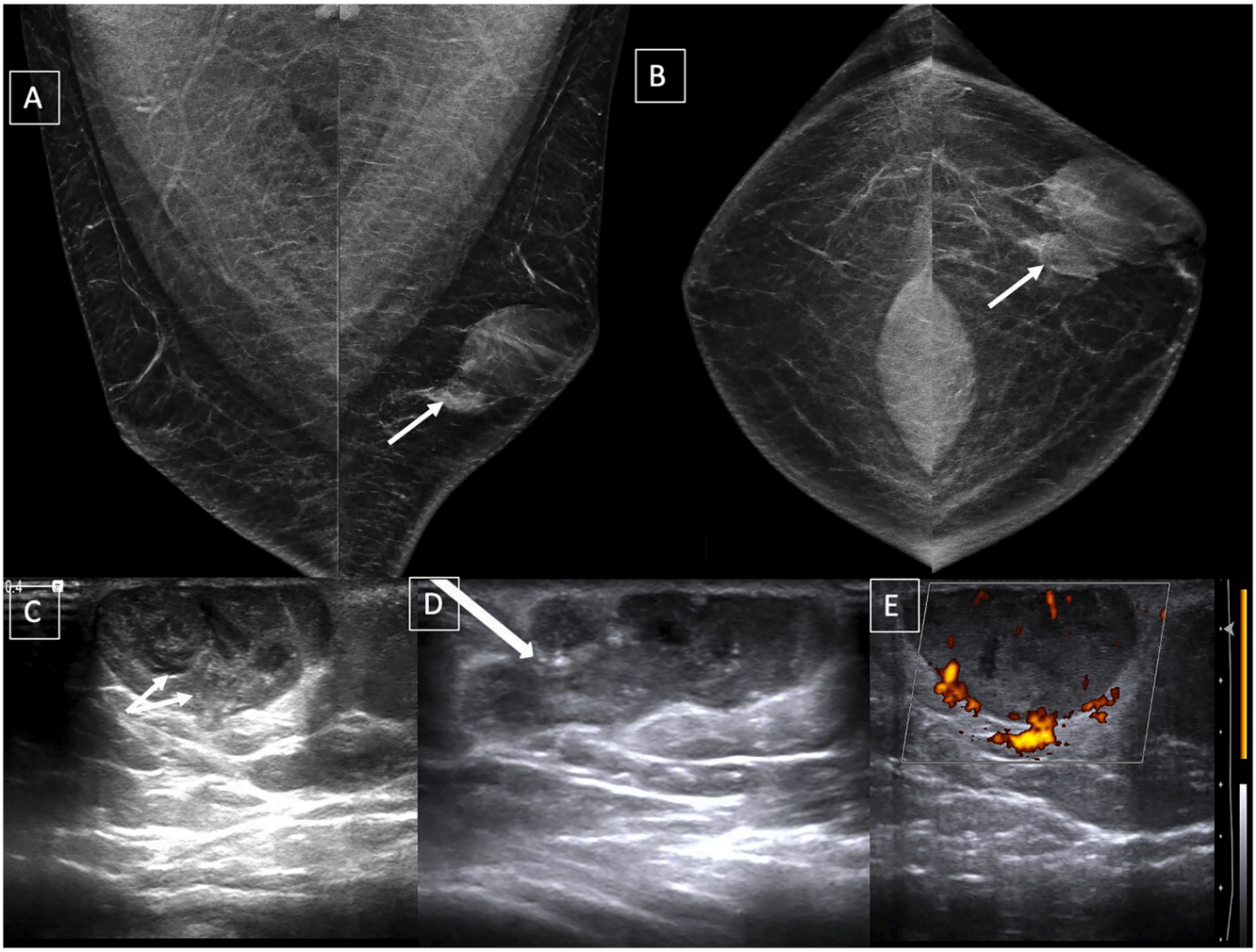

Fig. 8. A 24-year-old male came with a painful lump in the left breast after fine needle aspiration was done from the lump at another hospital. (A, B) Mammogram depicts, a well-circumscribed, oval, equal density mass close to skin surface in peri areolar location, with an undulation/ extension from its inferomedial margin (white arrow), suggestive of contained rupture. (C, D, E) US images showing an oval, circumscribed mass just under the skin, with alternate hypo- and hyperechoic rings giving the characteristic onion-ring like lamellated appearance of an epidermoid cyst (grouped white arrow), with an undulation (white arrow), suggestive of contained rupture. Increased perilesional vascularity was present.

following discussion delves into the clinical and radiological insights in various subtypes.

The incidence of ***acute puerperal mastitis*** varies from 2.5-20%, highest being in the first six weeks post-partum.[2,14,15] It accounted for 26% of the cases in our study. Majority of them presented with breast pain within one year of the last pregnancy. Risk factors include inadequate breast-feeding techniques causing incomplete emptying the breast. Milk stasis in the lactiferous ducts result in increased intraductal pressure and penetration of the milk into the surrounding connective tissue, initiating an inflammatory reaction (galactophoritis).[16] Breast suckling results in nipple cracks and sores, causing secondary infection from the babies' nasopharyngeal flora. The common causative bacteria include *Staphylococcus aureus* followed by coagulase negative Staphylococci, *streptococci, Escherichia coli, Bacteroides* or a polymicrobial infection. [14,17,18] Most of the patients in this study had already developed breast abscess at the time of presentation (Fig. 3). Treatment includes continued lactation, breast massage and hot fomentation. Antibiotics can be started to treat the secondary bacterial infection tailored to the culture-sensitivity results, taking care to choose those drugs which are safe for the infant.[11,19] US guided percutaneous drainage done for larger abscesses. Incision & drainage is usually reserved for recurrent or larger abscesses (> 5 cm).[19-21]

Non puerperal mastitis develops in non-lactating women during late reproductive years and includes subareolar (central) or peripheral subtypes. [22] We had two cases of central subareolar mastitis (Zuska's disease) in women aged 45 and 52 years. Both were diabetic with one of them having history of smoking (Fig. 4). Zuska's disease typically presents with recurrent abscesses, associated with a peri areolar draining sinus. The underlying pathogenesis is squamous metaplasia of the epithelial lining that causes plugging of the lactiferous ducts, resulting in stasis of secretions and inflammation. Secondary infection can result in abscess formation, especially in immunocompromised states.[1, 2,10, 23] Mammography shows irregular retro areolar mass or focal asymmetry, while ultrasound reveals an irregular thick-walled subareolar abscess with or without a draining sinus. The recommended treatment includes drainage, antibiotics and cessation of smoking.[24]

Tuberculous Mastitis (TM) was diagnosed in five patients having mean age of 36.7 years (4 females, 1 male) despite breast being rarely affected by tuberculous bacteria. Presentation included contiguous breast involvement from chest wall tuberculosis, disseminated tuberculosis, and isolated breast tuberculosis. These patients presented with chest pain, low grade fever, weight loss, palpable breast masses and discharging sinus. These findings were in concordance with earlier studies by Farrokh et al and Bahroon et al.[24-29] Presence of discharging sinus tracts was more prevalent in our study population. TM encompasses nodular, diffuse and sclerosing subtypes.[24-29] The nodular type

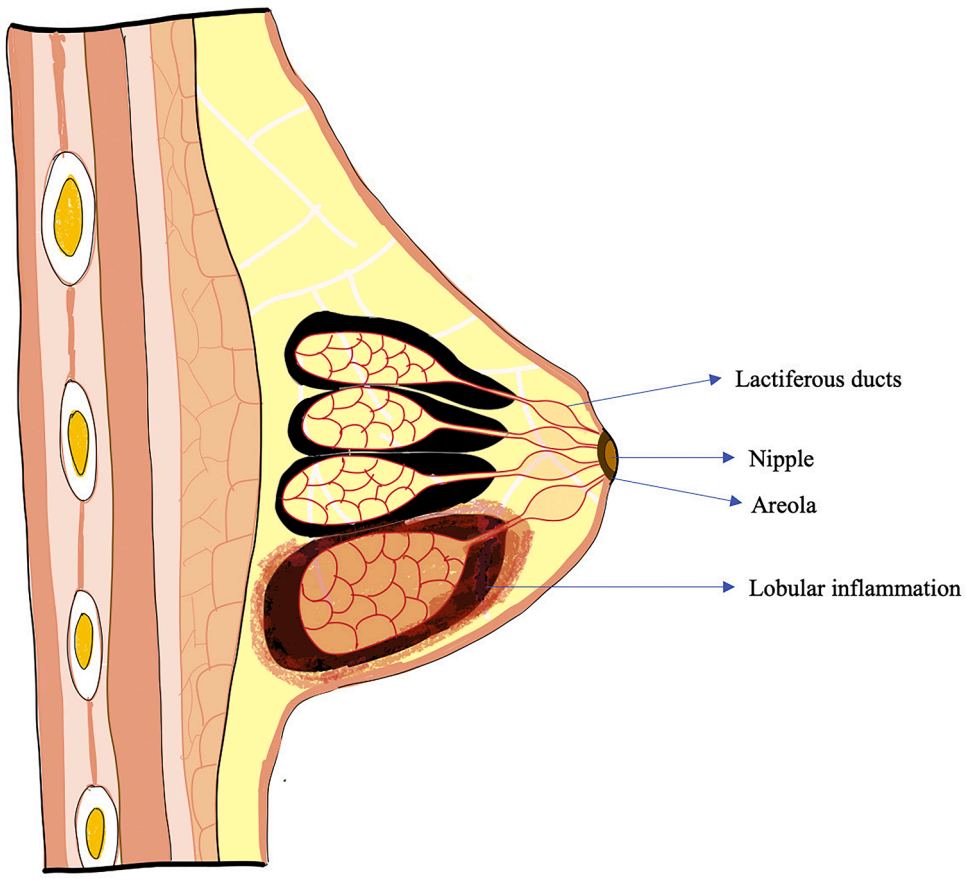

Fig. 9. Drawing illustrating inflammation of breast lobule forming a focal mass, characteristic of IGM.

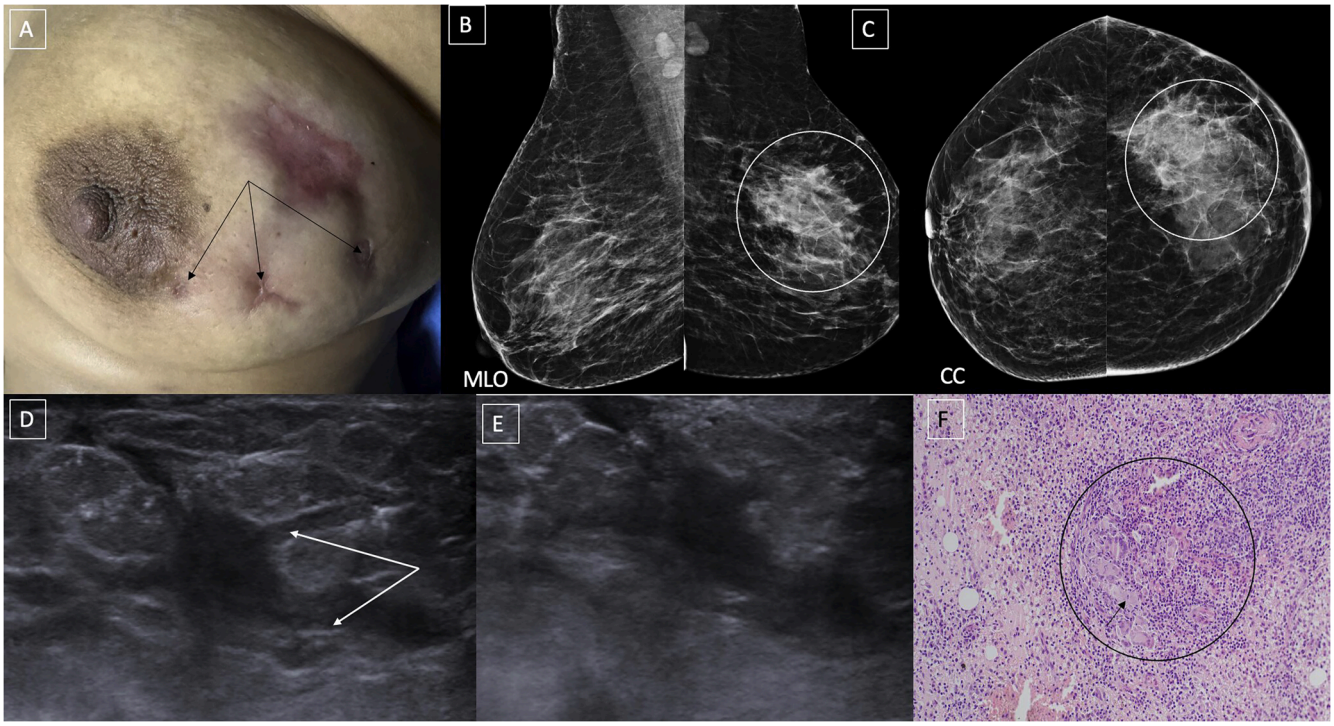

Fig. 10. A 37-year-old female presented with A: Multiple chronic discharging sinuses over her left breast (arrows) (B, C) MLO and CC views depicted focal asymmetry in the upper lateral quadrant of the left breast. (D, E) Ultrasound images revealed irregular hypoechoic lesion with linear tubular finger-like extensions insinuating into adjacent breast parenchyma (grouped arrows) (F) Photomicrograph illustrated dense inflammation with epithelioid granulomas (circle) as well as giant cells (arrow) (H& E, x200).

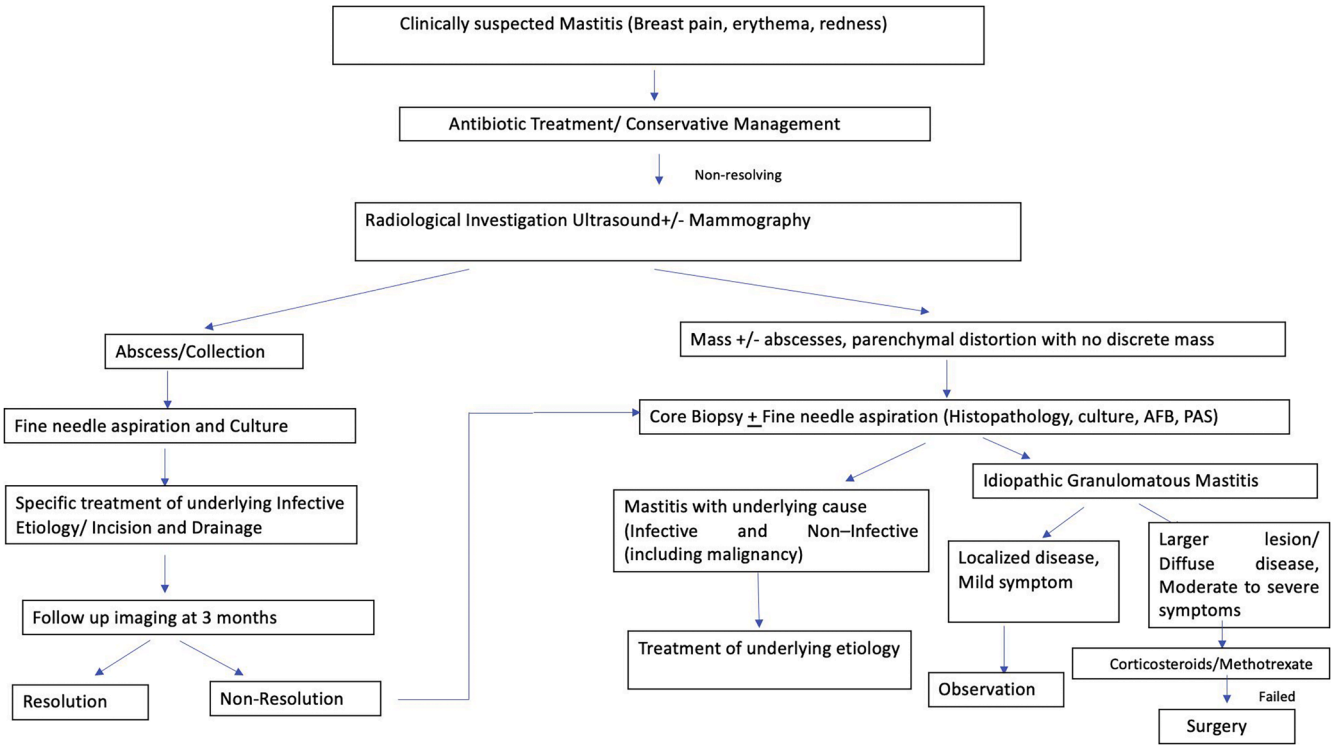

Fig. 11. Flow chart illustrating a comprehensive algorithmic approach to radiological assessment and management strategies in patients presenting with clinical symptoms of mastitis.

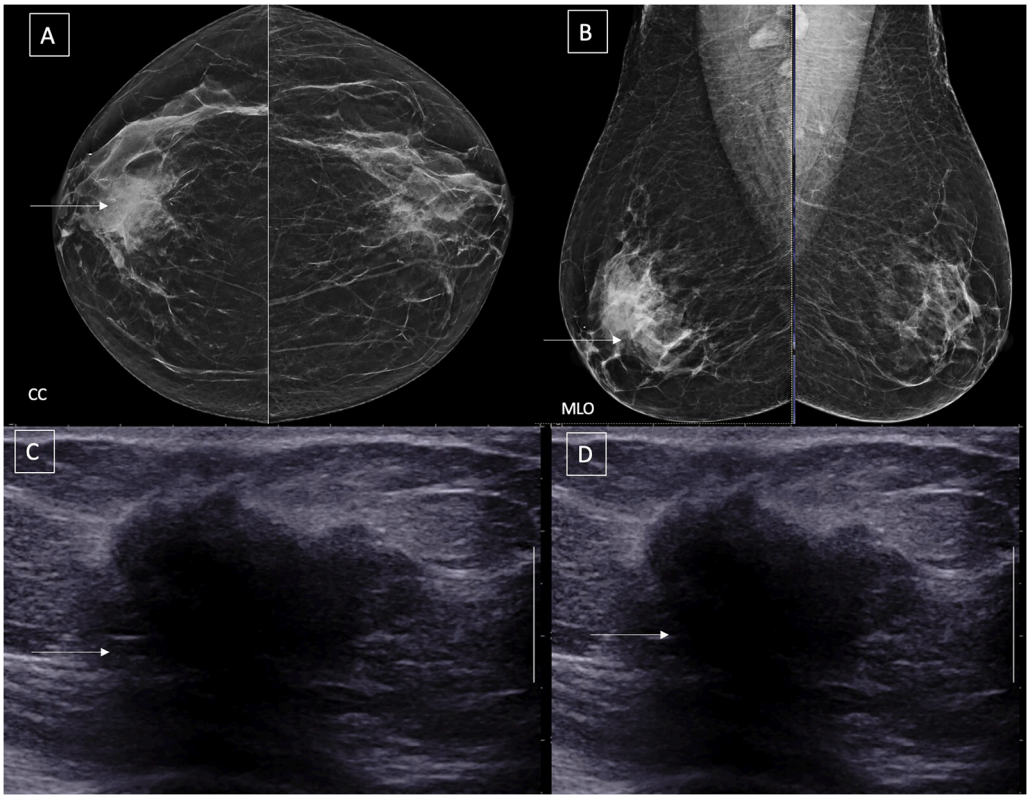

Fig. 12. A 50-year-old female, having type II diabetes mellitus for 15 years, complained of a palpable lump in her right upper breast. (A,B) Craniocaudal (CC) and mediolateral oblique (MLO) mammogram views show focal asymmetry in the right central breast (arrow). (C,D) Ultrasound images demonstrate an irregular hypoechoic mass with angular margins and extensive posterior shadowing at the area of the palpable lump, with no vascularity on colour doppler (not shown) . Ultrasonography-guided core biopsy from the mass using 14-gauge needle revealed dense fibrosis and B-cell lymphocytic infiltrate, leading to the diagnosis of diabetic mastopathy.

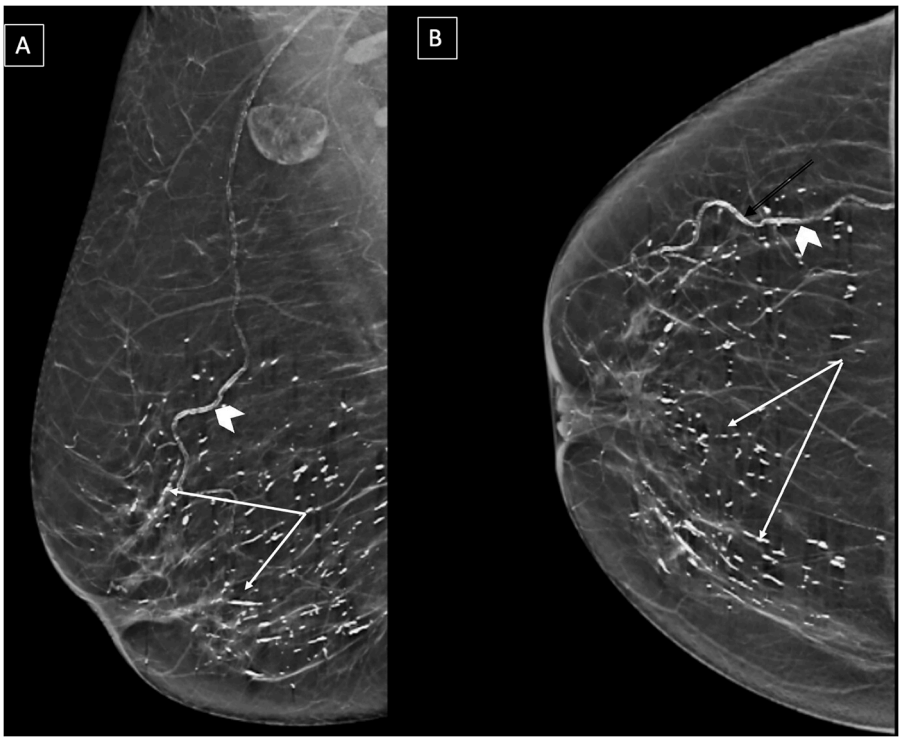

Fig. 13. (A, B): Mammography MLO and CC views representing smooth, linear, rod-like or cigar-shaped calcifications (white arrows) characteristic of plasma cell mastitis in a 60-year-old female. Note is also made of arterial calcifications (arrowhead).

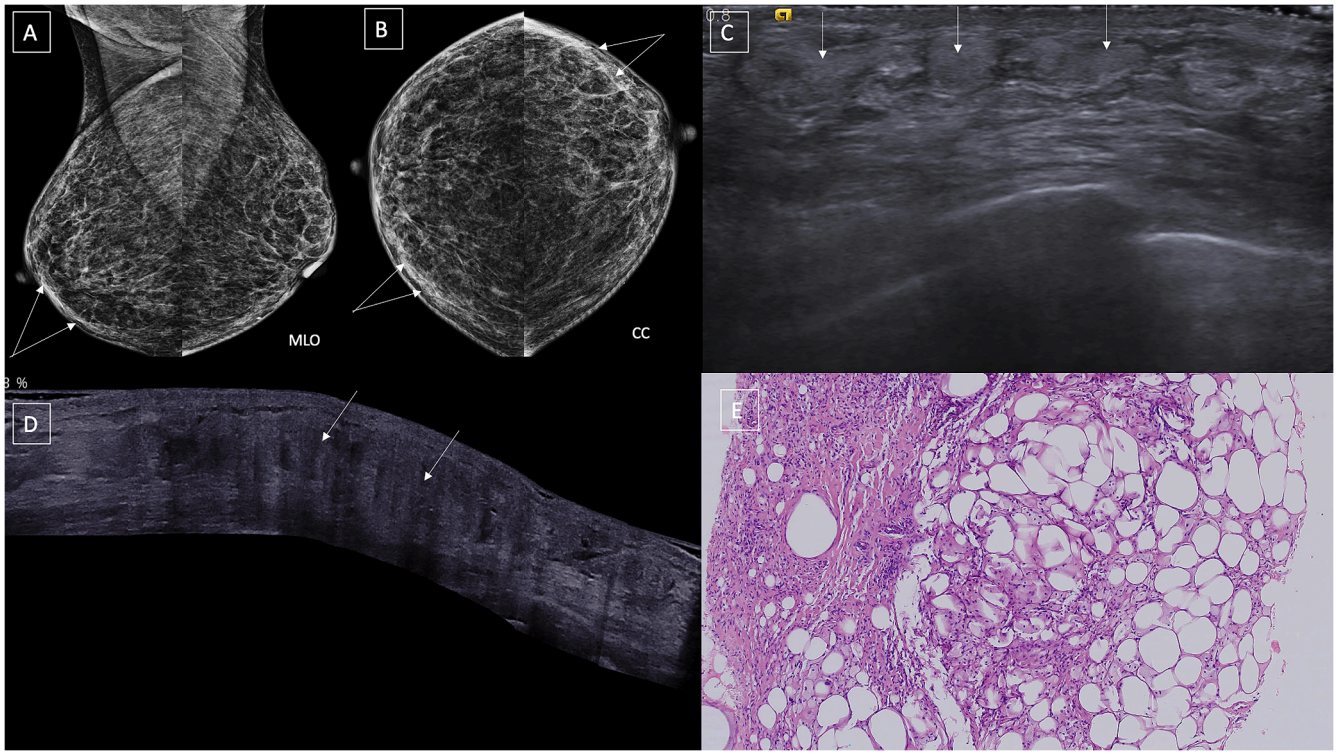

Fig. 14. A 65-year-old female presented to the breast clinic with diffuse tenderness in bilateral breasts for the past two months. (A, B) Full field digital mammography revealed ACR type B breasts with higher density noted characteristically in the premammary fat, symmetrically involving both breasts. (C, D) On US, there was higher echogenicity and diffuse nodularity of the entire subcutaneous and premammary fat of both breasts, better delineated on the extended field of view or panoramic view in D (white arrows). (E) US guided core needle biopsy using 14-gauge needle was done from hyperechoic nodular areas in the subcutaneous tissue. Photomicrograph showed the presence of moderate to dense lymphomononuclear inflammation and foamy macrophages involving the adipose tissue, consistent with diffuse panniculitis.

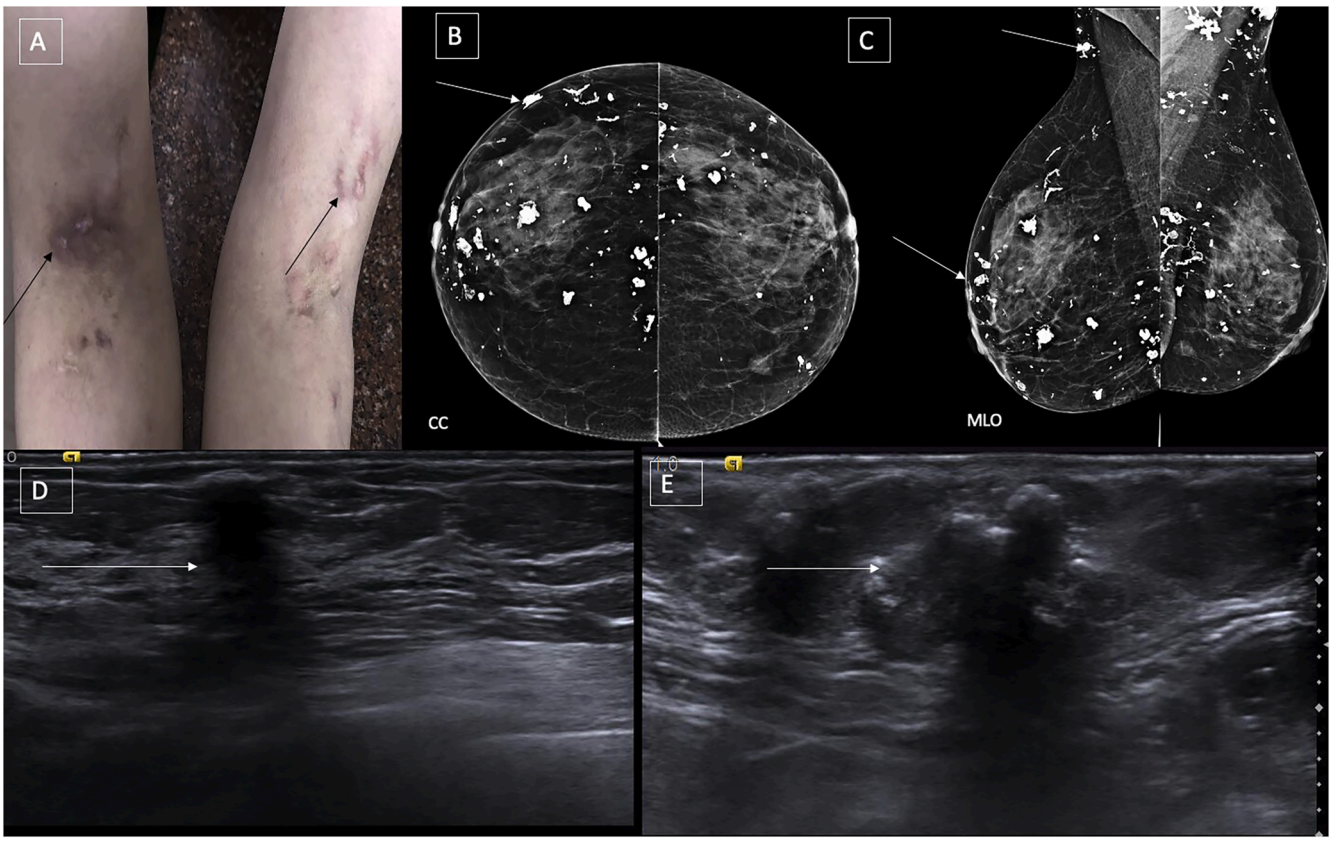

Fig. 15. A 47-year-old female presented with erythematous rash on extremities and bilateral breast lumps that were tender on deep palpation. (B, C) Full field digital mammography, CC and MLO views reveal bilateral multiple coarse dystrophic calcifications, many of which were localized to the subcutaneous plane, especially in the axillae (arrows). (D, E) Ultrasound depicted the presence of macrocalcifications with distal acoustic shadowing., mainly in the subcutaneous plane. On work-up patient was revealed to have dermatomyositis; hence a diagnosis of breast calcinosis was made.

shows axillary lymphadenopathy, indistinct high density breast mass with skin thickening and calcifications on mammography and irregular hypoechoic masses on ultrasound. Diffuse type appears as global or focal asymmetry on mammography with sonographic findings depicting heterogenous parenchyma and multiple communicating abscesses, draining sinuses as well as skin thickening (Fig. 5). Sclerosing type of TM presents with diffusely thickened skin, nipple retraction and a hard irregular breast mass resembling malignancy. Previous studies have also shown overlapping clinical and radiological findings of TM with breast cancer, IGM and fungal infections.[2,3,24-29] The diagnosis was confirmed by aspiration/biopsy, ZN staining and mycobacterial culture. All patients were treated with standard anti-tuberculous regimens.

Other infections included breast cysticercosis, filariasis and fungal aetiologies. US findings in patient with ***breast cysticercosis*** revealed anechoic cyst with an echogenic nodule representing the scolex (Fig. 6). Other sonographic findings previously described in literature include calcified cysticercoid cysts and irregular cystic fluid collection with extruded scolex.[30,31] The patient with ***filariasis*** presented with breast induration. Ultrasound findings were suggestive of a cystic lesion with thin internal hyperechoic strands showing random vigorous movements (Fig. 6, Supplementary video). These imaging findings were consistent with 'Filarial Dance sign' as previously quoted in literature.[32] ***Fungal mastitis*** is an extremely rare infection, usually develops in immunocompromised patients, and may mimic breast cancer.[33] An elderly lady with uncontrolled diabetes, skin ulceration and a nodular breast, had an irregular mass on ultrasound; which turned out to be fungal on biopsy, which has been rarely described in literature (Fig. 7). A male patient also presented with a breast lump and was later diagnosed as an ***infected epidermoid cyst*** (Fig. 8). Fine needle aspiration from the lump was previously attempted at peripheral hospital. The size of the lesion and pain accentuated post procedure due to leakage of keratin into the breast parenchyma. On ultrasound, the imaging findings showed characteristic subcutaneous location of the cystic mass with onion ring like lamellated appearance, with a tubular contained rupture emanating from the epidermoid cyst caused by aspiration. This case reinforces the colloquial term 'touch me not lesions' and underscores the pivotal role of radiologists in diagnosing such lesions through imaging alone.

Non-infectious mastitis can have varied clinical and radiological presentation. The diagnosis is predominantly made on biopsy.

Idiopathic Granulomatous Mastitis (IGM) is a chronic inflammatory breast condition predominantly affecting women of reproductive age, often within five years of pregnancy. In our study, IGM patients had age range 22-44 years, with mean age of 33.7 years, aligning with previous reports.[34,35] The exact prevalence of IGM remains uncertain. Baslaim et al. reported that histopathological confirmed cases of IGM accounted for 1.8% patients among 1106 women.[35] In contrast to previous literature, our study identified a relatively higher prevalence of this disease in the study population. Geographical, ethnic, and genetic factors may influence the prevalence of the disease with highest number cases reported from Turkey, China, and India, and predilection Hispanic and Asian predilection.[34-37] Its pathogenesis is linked to autoimmune disorders, pregnancy, lactation, hyperprolactinemia, oral contraceptive pills, and alpha 1 anti-trypsin deficiency. The association with *Corynebacterium kroppenstedtii* has also been proposed.[34-38]The most common clinical presentation in IGM is unilateral painful breast mass; with bilateral disease in 1-9% patients.[36-42] The most common mammographic finding in our study was focal asymmetry, while on ultrasound the most frequent finding was the presence of a hypoechoic mass with tubular extensions insinuating into the surrounding breast parenchyma, which was seen in 60% of our patients (Fig. 9,10). In a study by

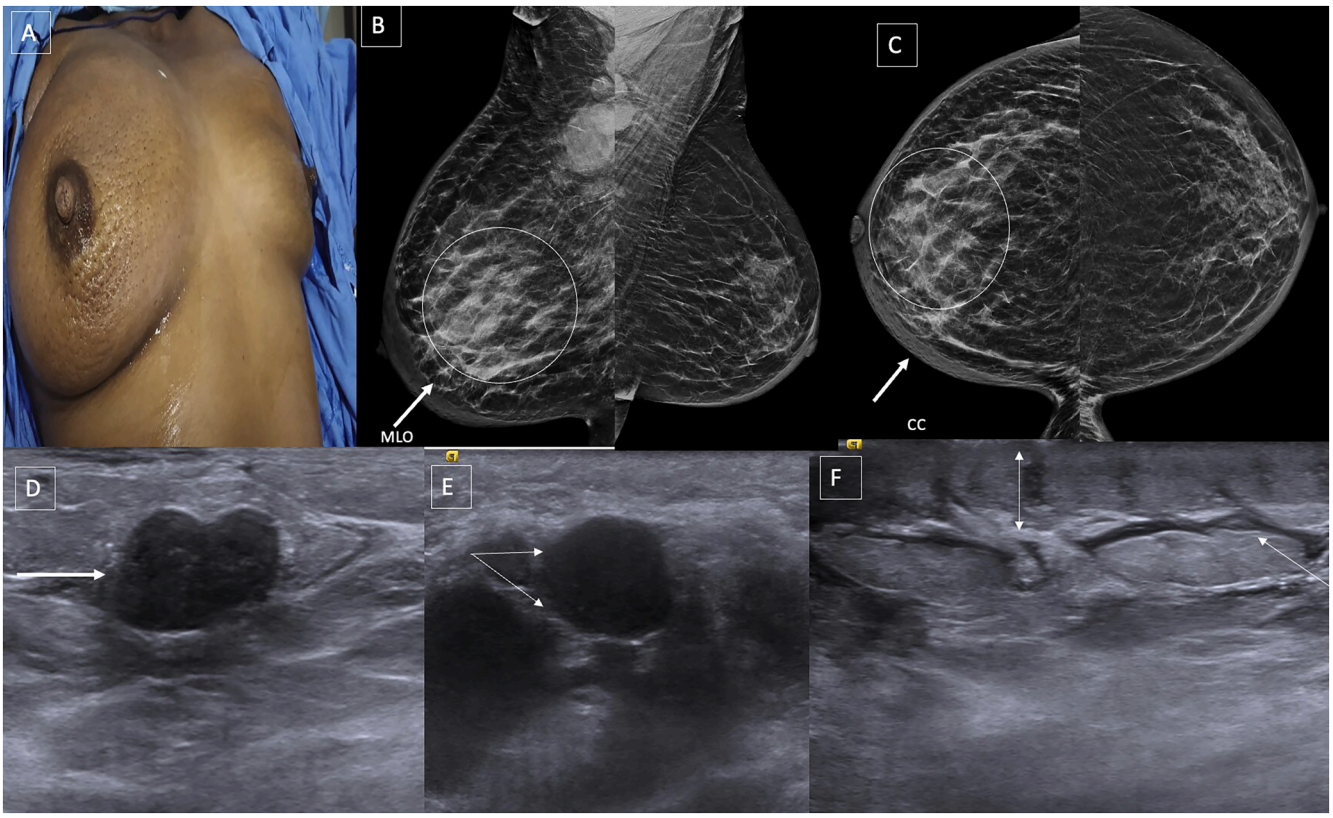

Fig. 16. A 54-year-old female came with painful right breast enlargement of six weeks duration. (A) Clinical photograph revealed peau d' orange appearance of the right breast. (B, C) Mammogram depicted focal asymmetry in the right breast (encircled), along with enlarged axillary lymph nodes and associated diffuse skin thickening involving >1/3rd of the right breast (white arrow). (D, E, F) Ultrasound revealed presence of a hypoechoic mass in the focal asymmetry (thick white arrow), with enlarged round axillary lymph nodes showing loss of fatty hilum (grouped arrows), along with diffuse skin thickening (double headed arrow) and dilated subdermal lymphatics (thin white arrow). A diagnosis of Inflammatory breast cancer or carcinomatous mastitis was made based on the clinicoradiological findings and the results of skin punch biopsy, which were consistent with lymphatic spread of carcinoma.

Aghjanzadeh et al. this finding was present in 59% of the patients.[34] The presence of tubular extensions likely represents destruction of the surrounding parenchymal lobules. Similar findings have been reported by Manogna et al.[37] MRI done in two patients with IGM showed the presence of segmental non-mass enhancement with multiple conglomerating rim enhancing small lesions and axillary lymphadenopathy. In IGM, histopathology reveals presence of sterile non-caseating lobulocentric granulomas in the background of macrophages, lymphocytes with relative sparring of the lactiferous ducts and fatty tissue.[3, 35, 40-43] The diagnosis is made after exclusion of other chronic inflammatory conditions including tuberculosis and fungal infections, sarcoidosis, and Wegner's granulomatosis.[3,40] There are no well-established protocols for the management of IGM. Follow up imaging with yearly mammography and 3-6 monthly ultrasound is recommended for incidentally discovered or mildly symptomatic patients, till complete resolution.[41,42] Lai et al. found that 50% of IGM resolved without treatment within an average of 14.5 months.[42] IGM does not respond to antibiotics and moderate to severe cases have been treated with oral corticosteroids in several studies.[41-44] Steroids are typically initiated at 1mg kg^{-1} per day and gradually tapered based on response.[43] Complete resolution may take 6-12 months, with higher rate of recurrence on discontinuation of steroids.[38,41] Methotrexate and bromocriptine are considered for relapsing or poorly responding cases.[44] The disease recurrence after surgical incision is reported as 5-50%, with complications such as wound infection, breast disfigurement, and fistula formation.[41-45] At our institution, imaging surveillance and oral corticosteroids is the mainstay of treatment (Fig. 11).There is need for documentation of US and mammography findings in patients with IGM, as tabulated in our study in Table 4.

Diabetic mastopathy (DM), also known as fibrocystic mastopathy, is characterised by inflammatory fibrous proliferation of the breast, and is typically seen in women with long standing diabetes mellitus. The incidence ranges from 0.6-13%.[3,47] The aetiology remains unclear but is believed to involve autoimmunity, with breast lesions containing B-cell lymphocytes expressing HLA-DR antigens.[2-4,46] Alternatively, DM may result from the body's inflammatory response to exogenous insulin.[47] Commonly presenting as painless palpable breast mass, bilateral breast involvement occurs in advanced stages. Mammographic findings are usually non-specific, including focal asymmetry or an indistinct mass. Sonographic findings typically reveal irregular hypoechoic masses with posterior acoustic shadowing. [2,3,8,41] The imaging findings can appear similar to malignancies. It is crucial for radiologists to be aware of the patient's clinical history, including the use of insulin that may affect the breast tissue.[46-47] This awareness is essential for accurate diagnosis and to avoid unnecessary surgical interventions. We identified only one case of DM during our study period (Fig. 12). Definitive diagnosis is usually by core needle biopsy and histopathological evaluation. The disease is usually self-limiting and resolves without treatment.[43]

Periductal mastitis is a non-infectious inflammatory breast condition seen mainly in perimenopausal or post-menopausal women.[2,3] Periductal mastitis (PDM) can be triggered by factors like bacterial infection, smoking, nipple invagination, obesity, and hyperprolactinemia.[2-4] Invagination of the nipple obstructs the lactiferous ducts, resulting in periductal inflammation. Mammography may show retroareolar tubular or branching structures, which might exhibit dense calcification. US can show dilated lactiferous ducts with intraluminal echogenic contents, with no vascularity on colour doppler.[2-4,10] PDM is histologically characterised by inflammation, fibrosis, and dilatation of the lactiferous

ducts with presence of lipid-laden histiocytes. Plasma cell mastitis is sterile response to extravasated intraductal secretion resulting in inflammation in periductal inflammation marked by plasma cell infiltration. We found characteristic rod like calcifications in one patient (Fig. 13).

Other rare non-infective pathologies encompassed a case of ***panniculitis*** which showed diffuse skin thickening with multiple subcutaneous nodules (Fig. 14).

Connective tissue diseases encompass a diverse array of conditions including scleroderma, dermatomyositis, systemic lupus erythematosus, and mixed connective tissue disease, marked by inflammation in connective tissues. The patients may be asymptomatic or present with breast heaviness, pain or indurations. The common imaging findings include skin and trabecular thickening with coarse calcifications as a sequalae to fat necrosis.[48] Two patients with ***dermatomyositis*** included in this study presented with complaints of breast pain and showed extensive dystrophic calcifications on mammography and ultrasound (Fig. 15).

The most concerning aetiology that needs to be ruled out among patients presenting with clinical features like that of mastitis is ***inflammatory breast carcinoma*** (IBC). The symptoms of IBC include breast erythema, pain, rapidly progressing hard lump often accompanied by axillary lymphadenopathy, usually of <3-6 months duration. Presence of diffuse skin thickening involving more than one-third of the breast, dilated lymphatics and underlying mass represent the common radiological findings (Fig. 16).

A comprehensive algorithmic approach to radiological assessment and management strategies in patients presenting with clinical symptoms of mastitis has been suggested by us as a flow chart in Fig. 11.

Our study has few limitations. It is a single centre study which may limit the generalisation of results to broader population. Secondly, retrospective data collection may have introduced bias or limitation in data accuracy. However, consecutive patients presenting to the hospital during the study period were included in the study.

Conclusion

Breast mastitis causes prolonged morbidity amongst women, exerting a significant burden on the healthcare systems. The convergence of endemic infections, limited resources, low awareness, suboptimal breastfeeding practices, and delayed treatment exacerbates this issue. This study indicates a notably higher incidence of puerperal and tuberculous mastitis among infectious pathologies. Intriguingly, the study also demonstrates an elevated prevalence of IGM, possibly influenced by geographical and ethnic factors. However, large-scale studies are imperative for conclusive insights. Radiological imaging is critical for establishing diagnosis, evaluating disease extent, guided interventions, and monitoring treatment response. Eventually, a comprehensive understanding of pathogenesis and an effective integrated multidisciplinary approach is necessary for prompt diagnosis, developing tailored management strategy and enhancing women's health outcomes globally.

Declaration of competing interest

The authors declare that they have no conflicts of interest concerning this article.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1067/j.cpradiol.2024.08.006.

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