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BENIGN BREAST LESIONS: DIAGNOSTIC VALUE OF MODERN IMAGING TECHNOLOGIES AND CLINICAL MANAGEMENT - A COMPREHENSIVE REVIEW

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ABSTRACT

Benign breast lesions comprise a wide spectrum of non-malignant proliferative, cystic, papillary, fibrotic, and inflammatory conditions that constitute the majority of abnormalities detected in breast imaging. Although inherently non-malignant, many of these lesions closely mimic malignancy on mammography, ultrasound, and MRI, presenting persistent diagnostic challenges in clinical practice. This review provides an integrated overview of the epidemiology, imaging characteristics, histopathologic features, and clinical management of the most common benign breast entities, including fibroadenoma, breast cyst, intraductal papilloma, sclerosing adenosis, fat necrosis, and radial scar.

Each entity is discussed with emphasis on distinguishing imaging findings, risk associations, and the importance of radiologic-pathologic concordance in guiding management. While lesions such as fibroadenomas and simple cysts typically demonstrate benign imaging profiles and require minimal intervention, other lesions-including papillomas, radial scars, and sclerosing adenosis-are more complex due to their variable appearance and association with increased breast cancer risk. Conditions like fat necrosis and radial scars exemplify benign mimickers of malignancy, frequently resulting in false-positive imaging assessments and necessitating tissue sampling.

A dedicated section highlights diagnostic pitfalls across imaging modalities and pathology, underscoring the value of multimodal assessment and careful evaluation of discordant findings. Collectively, this review reinforces the need for an individualized, correlation-driven diagnostic approach to ensure appropriate management, minimize unnecessary procedures, and maintain high diagnostic accuracy in contemporary breast imaging.

KEYWORDS

Benign Breast Lesions, Breast Imaging, Radiologic–Pathologic Correlation, Fibroadenoma, Intraductal Papilloma, Sclerosing Adenosis, Radial Scar

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1. Introduction

Breast cancer remains the most commonly diagnosed malignancy among women worldwide and a major cause of cancer-related mortality. According to recent GLOBOCAN analyses, more than 2.3 million new breast cancer cases and over 680,000 related deaths occur annually, representing approximately one in four cancer diagnoses in women [1,2]. The expansion of population-based mammographic screening has significantly improved early detection but has also increased the number of breast imaging abnormalities requiring diagnostic evaluation [3].

A large proportion of these findings represent benign breast lesions, a heterogeneous group of non-malignant proliferative, cystic, fibrotic, and inflammatory conditions. These lesions are substantially more common than malignant tumors, particularly in premenopausal women, and constitute the majority of abnormalities detected during screening assessment [4,5]. Their prevalence is strongly influenced by age, hormonal exposure, reproductive history, and breast density, with fibroadenomas and simple cysts being among the most frequently encountered benign lesions in routine clinical practice [5].

Although benign breast lesions lack metastatic potential, certain subtypes-especially proliferative lesions with or without atypia-are associated with a modest yet clinically relevant increase in long-term breast cancer risk [6]. Distinguishing benign from malignant lesions may be challenging, as several benign entities exhibit overlapping imaging features such as architectural distortion, irregular margins, or suspicious calcifications. These overlaps can contribute to unnecessary biopsies, patient anxiety, and increased healthcare utilization [3,5]. Standardized reporting frameworks such as the BI-RADS Atlas improve assessment consistency, though accurate differentiation still relies on radiologic expertise, clinical context, and careful radiologic–pathologic correlation [7].

2. Methodology

This review was prepared based on an analysis of scientific literature indexed in major academic databases, including PubMed, Scopus, and Web of Science. The search covered publications from 2000 to 2025 to ensure inclusion of both classical descriptions of benign breast lesions and the most recent evidence reflecting current diagnostic standards.

2.1. Search Strategy

The search included diagnostic and clinical terms related to benign breast pathology, such as: fibroadenoma, breast cysts, intraductal papilloma, sclerosing adenosis, fat necrosis, benign breast lesions, breast imaging, ultrasound, mammography, and MRI. Titles and abstracts were screened for relevance, followed by full-text assessment of eligible studies.

2.2. Inclusion Criteria

Studies were included if they met the following criteria:

- published in a peer-reviewed journal,
- written in English,
- focused on epidemiology, imaging characteristics, diagnosis, or management of benign breast lesions,
- original research, clinical guidelines, systematic reviews, or narrative reviews.

2.3. Exclusion Criteria

The following were excluded:

- case reports,
- conference abstracts lacking full methodological detail,
- non-indexed or non-scientific sources,
- studies unrelated to benign lesions or breast imaging.

2.4. Data Extraction

Data were extracted on:

- epidemiology and risk factors,
- characteristic imaging features across modalities,
- diagnostic pitfalls and differential diagnosis,
- recommended clinical management strategies.

3. Results: Overview of Common Benign Breast Lesions

3.1. Fibroadenoma

Definition

Fibroadenoma is a benign fibroepithelial breast tumor composed of a proliferation of stromal and epithelial elements. It typically presents as a well-circumscribed, mobile mass and is strongly influenced by hormonal factors. Histologically, fibroadenomas are classified into simple and complex variants, with complex forms containing additional elements such as calcifications, cystic spaces, or sclerosing adenosis [8].

Epidemiology

Fibroadenoma is the most common benign breast tumor in young women, with peak incidence between ages 15 and 35. It accounts for a large proportion of benign breast biopsies in premenopausal patients. Hormonal sensitivity contributes to typical behaviors such as growth during pregnancy and regression after menopause. Multiple or bilateral fibroadenomas may occur, especially in women with dense breast tissue or a family predisposition [9].

Imaging Characteristics

Mammography:

Fibroadenomas generally appear as round or oval, well-defined masses with smooth margins. With age-related involution, they may demonstrate classic “popcorn-like” coarse calcifications, which are highly specific for benignity.

Ultrasound:

The typical appearance is a homogeneous, hypoechoic, oval mass aligned parallel to the skin, with circumscribed margins and mild posterior acoustic enhancement. In younger women or highly cellular lesions, internal heterogeneity may be present, which can raise suspicion in the differential diagnosis [9].

MRI:

Fibroadenomas usually demonstrate circumscribed margins and persistent or plateau-type enhancement curves. Complex fibroadenomas may show internal septations or heterogeneous enhancement, but still maintain benign morphological features [10].

Management

Most fibroadenomas that exhibit classic benign features are managed conservatively with imaging surveillance.

Indications for biopsy or excision include:

- rapid interval growth,
- diameter > 3–4 cm,
- symptomatic lesions,
- patient anxiety,
- imaging–clinical discordance,
- suspicion of phyllodes tumor.

Stable lesions in young women can be followed for 1–2 years before returning to routine screening recommendations [10].

Diagnostic Pitfalls

Several benign and malignant lesions may resemble fibroadenoma on imaging:

- Phyllodes tumors may mimic rapidly enlarging fibroadenomas and often require biopsy.
- Complex fibroadenomas with cystic areas or calcifications may appear more suspicious, particularly in older women.
- Circumscribed carcinomas, though uncommon, can mimic fibroadenomas, requiring careful assessment of vascularity and margins.

Correlation between imaging, clinical presentation, and pathology remains essential for accurate diagnosis.

3.2. Breast Cysts (simple, complicated, complex)

Definition

Breast cysts are fluid-filled lesions arising from the terminal duct-lobular units. They form a spectrum from simple, anechoic cysts to complicated cysts with internal echoes, and complex cysts exhibiting septations, mural nodules, or solid components requiring further evaluation [11]. Cysts are common in adults, particularly women aged 35-50, and may also appear in adolescents, often in relation to hormonal changes [12].

Epidemiology

Breast cysts are among the most common benign breast lesions. In adolescents, they are less frequent but clinically important, especially when associated with menstrual irregularities or hormonal imbalances [12]. In adults, cysts frequently occur within the context of fibrocystic breast changes. Complex cysts carry a small but measurable risk of malignancy, especially in older women, whereas simple cysts are typically benign [13,14].

Imaging Characteristics

- Simple cysts:
- Well-circumscribed, anechoic, oval or round lesions with thin walls and posterior acoustic enhancement. They are considered definitively benign and usually require no intervention unless symptomatic [12,13].
- Complicated cysts:
- Contain low-level internal echoes caused by proteinaceous fluid, hemorrhage, or inflammation. No vascularized nodules are present. Follow-up imaging is usually sufficient [12].
- Complex cysts:
- Display suspicious features such as thickened walls, septations, mural nodules, or internal vascularity. These lesions require careful evaluation through core needle biopsy or surgical excision if indicated [11,13,14].

Management

- Simple cysts: Observation or aspiration for symptomatic relief.
- Complicated cysts: Short-term imaging follow-up; most are benign and resolve spontaneously [12].
- Complex cysts: Core needle biopsy or surgical excision is recommended. Persistent or recurrent cysts may require endocrinologic evaluation and, in adolescents, hormonal therapy [12].

Diagnostic Pitfalls

- Dense breast tissue or debris-filled cysts can mimic solid lesions.
- Small intracystic papillomas may be overlooked without careful assessment.
- Certain cystic carcinomas may appear deceptively circumscribed; Doppler evaluation of vascularity helps distinguish malignant features [11,13].

3.3. Intraductal Papilloma

Definition

Intraductal papilloma is a benign papillary epithelial proliferation composed of arborizing fibrovascular cores lined by both luminal and myoepithelial cells. These lesions arise within the ductal system and are classified into solitary central papillomas-typically located in the subareolar region-and multiple peripheral papillomas, which occur in the terminal duct–lobular units and are more frequently associated with epithelial atypia or adjacent proliferative changes [15].

Epidemiology

Papillary lesions account for approximately 2–7% of benign breast abnormalities sampled on core needle biopsy. Solitary papillomas are most commonly diagnosed in women aged 30–50 years and often present with unilateral serous or bloody nipple discharge. Peripheral papillomas occur less frequently but carry a higher likelihood of multifocality and an increased risk of associated atypical hyperplasia or in situ carcinoma, particularly when identified in younger patients or when multiple lesions coexist [17].

Imaging Characteristics

Imaging appearance varies depending on lesion size, location, and composition.

- Ultrasound:
- Intraductal papillomas typically appear as well-defined, intraductal soft-tissue nodules or as complex cystic–solid masses. A mural-based vascular nodule arising from the duct wall is a characteristic finding, and color Doppler often demonstrates flow within the fibrovascular stalk, aiding differentiation from debris or simple cystic material [16,19].
- Mammography:
- Central papillomas may appear as circumscribed retroareolar masses or ductal dilatations. Microcalcifications may be present, particularly in lesions with sclerosis or associated atypia, although small peripheral papillomas are frequently mammographically occult [16].
- MRI:
- Papillomas on MRI commonly demonstrate smooth, enhancing intraductal nodules or non-mass enhancement following ductal anatomy. Enhancement patterns can vary, but benign papillomas usually display homogeneous or segmental enhancement, whereas heterogeneous or irregular enhancement may raise suspicion for atypical or malignant papillary lesions [18].

Management

Management strategies depend on the presence of symptoms, lesion location, radiologic appearance, and histopathology.

- Solitary papillomas without atypia and with concordant imaging–pathology findings may be safely observed, as the risk of upgrade to carcinoma is low.
- Papillomas with atypia, peripheral papillomas, or lesions with radiologic–pathologic discordance warrant surgical excision given their significantly higher upgrade rates. Large cohort analyses demonstrate that atypia, peripheral location, and lesion multiplicity are strong predictors of malignancy upon excision [17,18].
- Symptomatic lesions, particularly those associated with spontaneous bloody nipple discharge, are typically excised both for symptom relief and definitive diagnosis.

Vacuum-assisted excision has emerged as a minimally invasive alternative for selected benign papillomas, although long-term outcome data remain under investigation.

Diagnostic Pitfalls

Papillary lesions pose substantial diagnostic challenges due to overlapping imaging features with papillary carcinoma and other intraductal or cystic–solid masses. Peripheral papillomas, in particular, may show irregular or heterogeneous sonographic patterns, mimicking malignancy. Conversely, small central papillomas can be under-recognized when ductal dilatation is subtle or when the intraductal mass is small and poorly visualized [16,19].

Sampling limitations of core needle biopsy represent a critical pitfall. Owing to the architectural complexity of papillary lesions, biopsy specimens may fail to capture atypical or malignant components. Large series have demonstrated notable upgrade rates upon surgical excision, necessitating careful radiologic–pathologic correlation and individualized management based on risk factors such as lesion multiplicity, size, and atypia on core biopsy [17,18].

3.4. Sclerosing Adenosis

Definition

Sclerosing adenosis (SA) is a benign proliferative lesion characterized by an increased number of distorted acini within the terminal duct–lobular units, embedded in a densely fibrotic stroma that may mimic invasive carcinoma on imaging and limited biopsy specimens [20]. Although SA is non-neoplastic, its architectural complexity and stromal sclerosis frequently produce features suggestive of malignancy, making accurate diagnosis dependent on radiologic–pathologic correlation [21].

Epidemiology

SA is commonly detected as an incidental finding in biopsies performed for other breast abnormalities and is most prevalent in premenopausal women. It often coexists with other benign proliferative lesions such as usual ductal hyperplasia or columnar cell change [22]. Wang et al. demonstrated that SA constitutes a substantial proportion of "lower-category" benign breast diseases and contributes meaningfully to the overall burden of proliferative lesions encountered in screening and diagnostic practice [24].

Breast Cancer Risk

Although benign, SA is associated with a **modestly increased long-term risk of breast cancer**. Wang et al. reported that women with SA have a significantly elevated risk compared with those without proliferative disease, highlighting SA as an independent contributor to breast cancer risk within the broader category of proliferative lesions without atypia [24].

Similarly, in the Mayo Benign Breast Disease Cohort, Visscher et al. demonstrated that SA confers a standardized incidence ratio (SIR) of approximately **2.1** (95% CI 1.9–2.3), confirming a two-fold increase in risk compared with the general population [23]. Importantly, SA itself does not further stratify risk within individual histologic categories, but its presence identifies a proliferative microenvironment associated with increased susceptibility to malignancy.

Imaging Characteristics

SA exhibits variable imaging appearances, frequently overlapping with malignant features.

- **Mammography:**
- SA may present as architectural distortion, focal asymmetry, or microcalcifications. Irregular or spiculated margins can closely resemble invasive carcinoma, especially in densely fibrotic areas [21].
- **Ultrasound:**
- Sonographic findings are diverse, ranging from hypoechoic lesions with indistinct margins to posterior acoustic shadowing caused by fibrosis. Occasionally, SA appears as a mass-like area without a discrete border, further mimicking malignancy [21].
- **MRI:**
- SA may demonstrate non-mass enhancement, segmental distribution, or plateau enhancement kinetics. These patterns significantly overlap with those seen in low-grade carcinoma and require careful evaluation in conjunction with mammography and ultrasound [22].

Management

Management depends on concordance between imaging and pathology.

Lesions with typical histologic findings and benign, concordant imaging features may be managed with routine surveillance [21]. When imaging findings are suspicious or discordant with biopsy results-particularly in cases with architectural distortion-repeat biopsy or surgical excision is recommended to exclude missed malignancy [22]. Because SA increases long-term cancer risk, ongoing clinical and imaging follow-up is appropriate, even when immediate intervention is unnecessary [23,24].

Diagnostic Pitfalls

SA is a recognized pitfall in both imaging and pathology. Dense fibrosis, distorted acini, and entrapped glands can closely simulate invasive carcinoma, especially in small core biopsy samples where myoepithelial cells may be attenuated but present [20]. Radiologically, posterior shadowing, stellate distortion, and non-mass enhancement significantly contribute to misclassification. High-quality radiologic–pathologic correlation is essential to avoid both under- and over-diagnosis.

3.5. Fat Necrosis

Definition

Fat necrosis is a benign inflammatory process of the breast resulting from injury to adipose tissue, most commonly following trauma, surgery, biopsy, radiotherapy, or infection [25]. Histologically, fat necrosis is characterized by disrupted adipocytes, lipid-filled macrophages, fibrosis, and-depending on the stage-calcifications or formation of oil cysts [26]. Although entirely benign, its clinical and imaging appearance frequently mimics malignancy, making accurate diagnosis essential.

Epidemiology

Fat necrosis represents a small but clinically relevant proportion of benign breast lesions. It is most commonly seen in women with a history of breast surgery or trauma, but it may also occur spontaneously in individuals with large or pendulous breasts where repetitive microtrauma is common [26]. Vasei et al. note that fat necrosis is encountered across a wide age range and can appear weeks to years after injury, often during follow-up imaging after breast-conserving surgery [28].

Imaging Characteristics

Fat necrosis exhibits a broad spectrum of imaging appearances depending on the stage of evolution.

- Mammography:
- Early fat necrosis may manifest as focal asymmetry, architectural distortion, or irregular masses. With time, lesions may develop the classic appearance of radiolucent oil cysts or coarse, peripheral ("eggshell") calcifications, which are highly characteristic and considered benign [26]. Taboada et al. emphasize that early, fibrotic stages are the most challenging, often resembling suspicious spiculated masses [27].
- Ultrasound:
- Sonographic features are highly variable: lesions may be anechoic, hypoechoic, hyperechoic, or mixed in echotexture. Posterior acoustic shadowing is frequently seen when fibrosis is prominent, whereas oil cysts may show posterior enhancement [25]. In some cases, fat necrosis may appear as an indistinct hypoechoic mass mimicking carcinoma, necessitating biopsy [27].
- MRI:
- Magnetic resonance imaging may demonstrate fat-signal intensity on non–fat-suppressed sequences or a fat–fluid level within an oil cyst. Peripheral rim enhancement can be observed; however, irregular or non-mass enhancement has also been documented and may raise concern for malignancy [25,28].

Because of this heterogeneity, fat necrosis is considered one of the classic “great mimickers” of breast cancer on imaging [27].

Management

Management depends on the concordance between imaging and clinical history.

- When imaging demonstrates classic features-such as oil cysts or rim calcifications-no further intervention is required, and routine surveillance is sufficient [26].
- If imaging findings are indeterminate or suspicious (e.g., architectural distortion, spiculated margins, suspicious enhancement patterns), image-guided core needle biopsy is recommended to exclude malignancy [25].
- Symptomatic lesions, such as painful masses, may be aspirated if cystic or surgically excised in rare cases of persistent discomfort, although this is infrequently necessary [26].

Vasei et al. highlight that awareness of the diverse imaging spectrum is essential to avoid both unnecessary biopsies and the underdiagnosis of suspicious lesions [28].

Diagnostic Pitfalls

The main diagnostic pitfall is the frequent resemblance of fat necrosis to invasive carcinoma. Early lesions may show spiculated masses, irregular margins, or suspicious calcifications on mammography and ultrasound [27]. Conversely, intermediate or late-stage lesions may appear deceptively benign, particularly when presenting as simple oil cysts [25].

Because clinical history of trauma or surgery is often absent or unclear, radiologic–pathologic concordance remains crucial. Even with biopsy, extensive fibrosis and atypical-appearing histiocytes may complicate interpretation, underscoring the need for careful evaluation in ambiguous cases [28].

3.6. Radial Scar / Complex Sclerosing Lesion (CSL)

Definition

Radial scar (RS), also referred to as complex sclerosing lesion (CSL) when larger than 1 cm, is a benign sclerosing lesion characterized by a central fibroelastic core with radiating ducts and lobules entrapped within the stroma [29]. Although histologically benign, RS/CSL often mimics invasive carcinoma due to architectural distortion, glandular entrapment, and stromal proliferation, making radiologic–pathologic correlation essential [31]. The lesion contains preserved myoepithelial layers, helping differentiate it from true invasive processes on histologic examination [29].

Epidemiology

RS/CSL is relatively uncommon, often identified incidentally during imaging or core needle biopsy performed for other breast findings. Ha et al. reviewed 117 lesions and noted that RS/CSL frequently occurs in women aged 40–60 years and is often associated with proliferative changes such as usual ductal hyperplasia, sclerosing adenosis, or columnar cell lesions [31]. According to Lv et al., RS is also clinically important because several cohort studies have demonstrated an elevated risk of subsequent breast cancer in patients with RS, supporting its classification as a proliferative lesion with increased long-term risk [33].

Breast Cancer Risk

A meta-analysis by Lv et al. demonstrated that women with radial scars have a significantly increased risk of breast cancer (pooled OR 1.33, 95% CI 1.12–1.58), with even higher risk observed in studies using histologic evaluation rather than imaging-only diagnosis [33]. The analysis further highlighted that RS contributes to breast cancer risk independently of other proliferative changes.

Kraft et al. evaluated RS/CSL identified on core biopsy and found malignancy present in 9% of cases undergoing surgical excision, underscoring the need for careful management and structured follow-up [30].

Imaging Characteristics

The appearance of RS/CSL varies across imaging modalities and often overlaps with malignant patterns.

- Mammography:
- Common findings include architectural distortion, spiculated masses, or central lucencies representing fibroelastic cores. Yan et al. emphasize that architectural distortion without an associated mass is a classic-but nonspecific-feature observed in many RS cases [29].
- Ultrasound:
- Sonographic features frequently include hypoechoic areas with irregular or spiculated margins, posterior acoustic shadowing, or ill-defined masses. RS may also appear as an area of architectural distortion without a discrete mass, which can resemble invasive carcinoma [31].
- MRI:
- MRI findings range from non-mass enhancement in a stellate configuration to irregular enhancing masses. Trombadori et al. reported that RS may show progressive or plateau enhancement patterns, with features that frequently mimic malignancy, particularly in larger lesions [32].

Because of these variable presentations, RS/CSL is considered a major radiologic mimic of invasive carcinoma.

Management

Management strategies remain debated but are increasingly guided by radiologic–pathologic concordance.

- Concordant benign RS/CSL without atypia
- According to Ha et al., lesions that show concordance between benign imaging features and core biopsy results can be safely managed with imaging surveillance rather than routine excision [31].
- RS/CSL with atypia or radiologic–pathologic discordance
- Kraft et al. found that the presence of atypia markedly increases upgrade risk, and such cases should undergo surgical excision [30].
- Active surveillance
- Recent observational data suggest that small, concordant RS/CSL lesions without atypia may be monitored safely. Trombadori et al. reported favorable outcomes with structured imaging follow-up, although larger or suspicious lesions still warrant excision [32].

Overall, management must be individualized, with excision recommended for atypical or discordant lesions, while stable, benign-appearing concordant lesions may be observed.

Diagnostic Pitfalls

RS/CSL is one of the most challenging benign breast entities due to its close resemblance to invasive carcinoma. Architectural distortion, spiculated margins, irregular enhancement, and posterior shadowing are common imaging pitfalls shared with malignancy [29,31].

Histologically, the central fibroelastic core and entrapped glands of RS may simulate tubular carcinoma or low-grade invasive carcinoma, particularly in limited biopsy samples [29].

Kraft et al. note that underdiagnosis may occur when imaging suggests malignancy but biopsy retrieves only a small portion of the lesion, stressing the importance of performing imaging-guided sampling with sufficient tissue volume [30].

4. Discussion: Diagnostic Challenges

Diagnosing benign breast lesions remains challenging because many of them mimic malignancy on imaging and even on histopathologic examination. A broad spectrum of entities-including fibroadenoma, sclerosing adenosis, fat necrosis, intraductal papilloma, and radial scar/complex sclerosing lesion-can exhibit architectural distortion, irregular margins, suspicious calcifications, or atypical enhancement patterns that overlap substantially with those of invasive carcinoma. Torous et al. emphasize that benign lesions with complex architecture, myoepithelial attenuation, and stromal fibrosis are frequent sources of overinterpretation, especially in limited core biopsy samples [34].

From an imaging perspective, several recurring patterns are responsible for false-positive assessments. Guirguis et al. highlight that architectural distortion, spiculated or irregular masses, and non-mass enhancement on MRI are common triggers for BI-RADS 4 or 5 categorization, yet may arise from benign pathologies such as radial scars, sclerosing adenosis, or fat necrosis [35]. Durur-Subasi et al. further showed that benign conditions including fat necrosis, fibrocystic changes, granulomatous mastitis, and sclerosing adenosis can demonstrate rim or heterogeneous enhancement, washout kinetics, and segmental or regional non-mass enhancement on MRI, closely resembling malignant lesions [37]. These overlaps underscore the necessity of integrating MRI findings with mammographic and ultrasound features as well as the clinical context, rather than relying on a single modality.

Pathology introduces its own pitfalls. According to Torous et al. and Quinn, complex sclerosing lesions, proliferative fibroepithelial tumors, and papillary proliferations may show crowded glands, sclerosis, and epithelial hyperplasia that simulate low-grade invasive carcinoma or ductal carcinoma in situ [34,36]. In addition, myoepithelial cells may be markedly attenuated or difficult to demonstrate on routine stains, making the distinction between in situ, invasive, and benign sclerosing processes challenging [36]. These issues are particularly pronounced in small or superficial core biopsy specimens that sample only part of a heterogeneous lesion.

Radiologic–pathologic discordance is therefore a central theme in the diagnostic work-up of benign breast lesions. Guirguis et al. stress that when imaging suggests a suspicious lesion (e.g., spiculated mass, marked architectural distortion, or BI-RADS 4/5 non-mass enhancement), but the core biopsy yields a benign diagnosis without a clear correlate, this discordance must not be ignored [35]. In such cases, repeat biopsy with improved targeting or surgical excision is recommended to avoid missed cancers. Conversely, lesions with typical benign imaging features and concordant benign histology can safely be managed with imaging follow-up, thereby reducing unnecessary surgery and overtreatment [34,35].

Several strategies consistently emerge from the literature as effective ways to minimize diagnostic error. First, strict application of radiologic–pathologic correlation is essential for all biopsied lesions [35]. Second, awareness of the characteristic but variable appearances of key benign mimickers-such as sclerosing adenosis, fat necrosis, and radial scars-can help radiologists recognize when a lesion's behavior is typical for a benign entity rather than malignancy [34,37]. Third, using a multimodality approach, rather than relying on a single imaging technique, improves confidence in both benign and suspicious assessments [35,37]. Finally, close collaboration between radiologists and pathologists, including joint review of discordant or equivocal cases, helps to resolve uncertainties and avoid both missed cancers and unnecessary operations [34–36].

In summary, benign breast lesions pose significant diagnostic challenges because their imaging and histopathologic features often overlap with those of carcinoma. An individualized, correlation-driven approach that integrates clinical, radiologic, and pathologic information is crucial to distinguish genuinely suspicious lesions from benign mimickers, thereby optimizing patient care.

5. Conclusions

Benign breast lesions represent a diverse group of proliferative, cystic, fibrotic, inflammatory, and papillary processes that collectively account for the majority of abnormalities detected in contemporary breast imaging. Although non-malignant, many of these lesions share radiologic and histopathologic features with breast cancer, creating significant diagnostic challenges and necessitating careful radiologic–pathologic correlation. Understanding the characteristic imaging patterns, clinical contexts, and natural histories of these entities is essential to avoid unnecessary interventions while ensuring appropriate evaluation of lesions that carry an increased risk of malignancy.

Among the most common benign lesions, fibroadenomas and simple cysts typically display characteristic benign imaging findings and require only routine surveillance or symptom-directed management. In contrast, proliferative lesions such as intraductal papillomas and sclerosing adenosis warrant greater diagnostic attention due to their architectural complexity and association with elevated long-term breast cancer risk. Fat necrosis and radial scars further exemplify benign mimickers of malignancy, often producing spiculated margins, architectural distortion, or suspicious enhancement patterns that demand precise correlation between imaging and pathology.

Across all benign entities reviewed, the central theme is the need for individualized management guided by concordance between clinical findings, imaging characteristics, and biopsy results. When discordance occurs, additional sampling or surgical excision remains the safest approach. Advances in breast imaging, including high-resolution ultrasound and MRI, continue to improve diagnostic accuracy but also introduce new pitfalls, particularly in lesions with variable or evolving appearances.

A comprehensive understanding of benign breast lesions-combined with a structured, correlation-driven diagnostic framework-allows clinicians to balance the goals of minimizing overtreatment while ensuring timely detection of clinically significant disease. This approach strengthens diagnostic precision, reduces unnecessary biopsies, and supports optimal patient care in modern breast imaging practice.

Disclosure

Authors' contributions

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