


# MR Imaging features of Lipid-rich Carcinoma of Breast

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## ABSTRACT

Lipid-rich carcinoma is an extremely rare type of invasive breast cancer, and its diagnosis based on histology, in which no fewer than 90% of tumor cells contain intracytoplasmic lipids [1]. Lipid-rich carcinoma has more aggressive clinical behavior and poorer prognosis than invasive ductal carcinoma. Therefore, early diagnosis of lipid-rich carcinomas based on preoperative imaging is imperative for providing proper treatment and improving prognosis. To our knowledge, MRI features of lipid-rich carcinomas has not been reported. In this article, we report MRI features of lipid-rich carcinoma in a 59-year-old female. Here, we discuss the histological features, MRI features, differential diagnosis, and treatment of lipid-rich carcinoma. Studying these aspects can help to establish well-defined diagnostic criteria and guide appropriate clinical treatment.

## CASE REPORT

### CASE REPORT

A 59-year-old female visited our hospital with a mass in the left breast. Physical examination revealed a palpable, painless, firm, well-defined, and slightly mobile mass without nipple discharge or skin discoloration. The patient had a medical history of meningioma, hypertension, and thyroidectomy. She had no family history of cancer and gave birth to two children.

Initial ultrasonography showed a hypoechoic mass in the left breast, with clear boundary, irregular shape (Fig 1A), and enlarged lymph nodes in the axillary region (Fig 1B). Subsequently, breast MRI was performed, revealing a round, lobulated, and solid mass with smooth borders measuring 1.5 cm × 1.4 cm × 1.4 cm in the left breast at the 2 o'clock position, located 5 cm from the nipple. The mass appeared isointense on T1-weighted images (T1WI) (Figure 2A), hyperintense on fat-saturated T2-weighted images (FS-T2WI) (Figure 2B) and diffusion-weighted imaging (DWI) (Figure 2C), and displayed a low apparent diffusion coefficient (ADC) (Figure 2D). After gadolinium injection, the mass showed obvious and homogeneous enhancement (Figure 2E), with the time signal intensity curve (TIC) demonstrating a wash-out type (Figure 2F). The axillary lymph nodes are slightly enlarged. Based on MR features, the lesion was diagnosed as a malignant lesion and categorized as Breast Imaging-Reporting and Data System (BI-RADS) 4b.

Radiologic workup included a CT enhancement of the chest, abdomen, and pelvis, as well as MRI enhancement of brain and spine to exclude distant metastasis and complete staging workup of the breast lesion. The results showed no evidence of distant

metastasis. Extensive laboratory testing was performed, tumor biomarkers of cancer antigen 15-3 were slightly increased, other routine biochemical, haematological, and hormonal investigations were within normal ranges.

Radical mastectomy of left breast and sentinel lymph node biopsy were performed. Hematoxylin-eosin (H&E) shows tumor cells as clusters of atypical, large, vacuolated tumor cells (Figure 3) and confirmed as lipid-rich carcinoma (Grade II). Six sentinel lymph nodes were isolated and one exhibited metastasis. Lymphovascular invasion was not observed. Immunohistochemical staining showed that cytokeratin 5/6, P63, and human epidermal growth factor receptor type 2 (Her-2) were negative; E-cadherin, P53, estrogen receptor (ER), and progesterone receptor (PR) were positive, the ki-67 index was 60%. After surgery, the patient was started on seven cycles of chemotherapy and thirty-one cycles of radiation therapy, followed by hormonal therapy. She tolerated this treatment well and showed a good clinical response for six years, with regular follow-up appointments ongoing.

### DISCUSSION

#### Etiology & Demographics

Lipid-rich carcinoma (LRC), also known as lipid-secreting carcinoma, was first described by Aboumradi in 1963 [2]. According to WHO's new classification of breast cancer in 2019, it is a rare and independent type of breast cancer, with a proportion of <1~1.6% among breast cancer [3]. The risk factors for LRC are unknown, only 80 cases (age ranging from 10 to 81 years) have been reported in the literature to date. Most cases are female; two cases were reported in males.

### Clinical & MR imaging findings

Breast lumps and nipple discharge were the predominant symptoms. To our knowledge, no studies have systematically described the MR features of LRC. In this case, the tumor presented as a round and lobulated shape with smooth borders and displayed high signal intensity on FS-T2WI. These features are also commonly observed in benign lesions, such as fibroadenomas, thus leading to the potential misdiagnosis as benign lesions. However, other MRI features suggested as malignant lesions, such as, the mass showed high signal intensity on DWI and low ADC values. After injection of gadolinium-based contrast agent, the mass showed obvious and homogeneous enhancement, without cysts or necrosis, and the TIC showed a washout tape. LRC frequently develops lymph node metastasis. MRI play an important role in the assessment of breast lesions and axillary lymph nodes to complete staging workup and achieve an accurate surgical protocol.

### Pathophysiology

LRC has special histological and immunohistochemical features and usually presents as a poorly differentiated invasive breast cancer. The tumors were large and polygonal, with abundant vacuolated or foamy cytoplasm and full of neutral lipid cells. No fewer than 90% of tumor cells contain intracytoplasmic lipids. The lipids in these cancer cells are similar to those in brown adipose tissue [4]. Most LRC were considered ER and PR negative, HER-2 protein was found to be overexpressed in 71.4% of LRC, much higher than the 20 -30% positive rate for invasive breast cancer. However, the significance of Ki-67 levels in LRC has not been elucidated [5].

### Treatment & Prognosis

Owing to the rarity of LRC, there are currently no standard guidelines. Considering the aggressiveness of LRC, radical surgery and systemic therapy are frequently used clinically. Endocrine therapy has a limited effect because most of LRC are ER-negative. Chemotherapy is the most important treatment option. An antitumor drug sensitivity test showed that most LRC were sensitive to paclitaxel, carboplatin, cisplatin, teniposide, and vincristine but resistant to adriamycin, rubidomycin, cytarabine, and methopterin [3]. LRC has a more aggressive clinical course and a worse prognosis than other types of breast cancer. LRC frequency has lymph node metastasis at the time of surgery [4], and some patients develop distant metastasis during follow-up, with very poor 5-year survival rates (Table 1) [6].

### Differential Diagnoses

In this case, LRC presented characteristics consistent with both benign and malignant lesions, which can lead to misdiagnosis. Considering these overlapping features, fibroadenomas, invasive duct carcinoma (IDC), and mucinous carcinoma are considerations in the differential diagnosis of LRC, as stated in the differential diagnoses in table 2.

### Fibroadenomas

Fibroadenomas are the most common benign tumor of the breast. The boundary characteristics of fibroadenomas (smooth margins and round or lobulated shapes) are generally similar to those of LRC. The main differences are that most fibroadenomas showed high signal intensity on FS-T2WI, inner septation defined as typical signs [7], and only a slightly high signal on DWI, compared with the normal breast parenchyma. Conversely, LRC has a higher signal on DWI and a lower ADC than fibroadenoma due to the high cellularity in most malignant tumors [8]. On dynamic contrast-enhanced imaging, fibroadenomas appear as gradually enhancing lesions, the TIC appear as a persistent or plateau tape [8], while LRC demonstrates a washout tape.

### IDC

IDC is the most common type of breast cancer. As malignant breast tumor, IDC usually appears as a heterogeneous, diffusely enhancing mass or as an enhancing peripheral nodular mass. On MRI, the typical characteristics of some malignant breast lesions (higher signal intensity on DWI and a lower ADC value, and wash-out tape in TIC) may also result in inaccurate differentiation between LRC and IDC. However, the morphological characteristics of IDC in malignant breast lesions (spiculated and irregular, peritumoral edema, adjacent vessel sign) generally differ from those of LRC (smooth and lobular). The combination of morphological and enhancement properties leads to increased diagnostic specificity.

### Mucinous carcinoma

Mucinous carcinoma is a lobulated, oval, or round mass with smooth border. These features overlap with LRC. The main difference is that mucinous carcinoma typically shows an extremely high signal intensity on FS-T2WI, equivalent to water-filled cysts [9]. On T1WI, mucinous carcinoma can be hypo- to isointense compared to the normal gland, depending on the protein content [10]. Mucinous carcinoma shows lower signal intensity on DWI and increased ADC values when compared with LRC because of low cellularity and abundant mucin, which do not restrict diffusion [11]. In dynamic contrast enhancement, mucinous carcinomas appear as slightly, gradually enhancing lesions and show a plateau or persistent tape [12], while LRC shows a washout tape. Thus, these features may help to differentiate LRC from mucinous carcinoma.

### TEACHING POINT

No studies have systematically described the MR features of LRC. Here, we report a case of LRC with sentinel lymph node metastasis. In this case, LRC presented both benign and malignant lesion features, leading to a misdiagnosis. We focused on summarizing the MR features and differential diagnoses to recognize its typical signs on MR, increasing diagnostic specificity, and further help the treatment and prognosis.

## QUESTIONS & ANSWERS

**Question 1:** What is the most common pathological type of breast cancer?

1. Mucinous carcinoma
2. Medullary carcinoma
3. Tubular carcinoma
4. Papillary carcinoma
5. Invasive ductal carcinoma (applies)

**Explanation:** [Invasive ductal carcinoma is the most common pathological type of breast cancer], accounting for approximately 80% of all cancers, followed by invasive lobular carcinoma, accounting for approximately 10% of invasive breast cancers. Unusual breast tumors include mucinous, tubular, medullary, and papillary carcinomas, which account for the remaining 10% of invasive breast tumors.

**Question 2:** Which of the MRI findings of lipid-rich carcinoma in the following answer choices are false?

1. Round mass with smooth borders
2. The tumor demonstrates T1 isointense and T2 hyperintense
3. The mass is prone to cystic and necrosis (applies)
4. High signal intensity on DWI and low ADC value
5. Homogeneous enhancement and wash-out tape

**Explanation:**

1. Round mass with smooth borders [the tumor shows a round and lobulated shape with smooth borders]
2. The tumor demonstrates T1 isointense and T2 hyperintense [the mass shows as isointense to the normal gland on T1-weighted images, high signal intensity on fat-saturated T2-weighted images.]
3. The mass is prone to cystic or necrosis [the mass shows homogeneous enhancement, without cystic or necrosis.]
4. High signal intensity on DWI and low ADC value [the mass shows high signal intensity on DWI and low ADC values.]
5. Homogeneous enhancement and wash-out tape [the time-signal intensity curve shows a wash-out tape]

**Question 3:** What are not the characteristics of the malignant breast lesions?

1. Spiculated and irregular
2. Peritumoral edema
3. Adjacent vessel sign
4. Wash out type in dynamic enhancement
5. Smooth borders (applies)

**Explanation:**

1. Spiculated and irregular 2. peritumoral edema 3. adjacent vessel sign [the boundary characteristics of IDC of malignant breast lesions (spiculated and irregular, peritumoral edema, adjacent vessel sign)]
4. Wash out type in dynamic enhancement [On MRI, overlap in some malignant breast lesions (wash out type in dynamic enhancement)]
5. Smooth borders [The boundary characteristics of benign tumors, such as fibroadenomas (smooth margins)]

**Question 4:** Which of the following answer choices are false?

1. Cells containing abundant lipids are typical signs of lipid-rich carcinoma.
2. Lipid-rich carcinomas exhibit a more aggressive clinical behavior.
3. Lipid-rich carcinoma frequency has lymph node metastasis.
4. Chemotherapy is the most important treatment for patients with lipid-rich carcinomas.
5. Endocrine therapy is feasible for all breast cancers. (applies)

**Explanation:**

1. The cells containing abundant lipids are typical signs of lipid-rich carcinoma. [LRC of the breast is an invasive breast cancer in which no fewer than 90% of the cells contain abundant cytoplasmic neutral lipids]
2. Lipid-rich carcinoma has more aggressive clinical behavior. [LRC has a more aggressive clinical course and a worse prognosis than other types of breast cancer.]
3. Lipid-rich carcinoma frequency has metastasis. [LRC frequency has lymph node metastasis at the time of surgery [3], and some patients develop distant metastasis in the follow-up.]
4. Chemotherapy is the most important part of the treatment for lipid-rich carcinoma. [Chemotherapy is the most important part of the treatment]
5. Endocrine therapy is feasible for all breast cancers. [endocrine therapy is feasible for breast cancer of estrogen receptor-positive.]

**Question 5:** What is the predilection site of metastatic breast cancer?

1. Sentinel lymph node (applies)
2. Liver
3. Bone
4. Lung
5. Brain

**Explanation:**

Breast cancer commonly develops sentinel lymph node metastasis followed by bone metastasis.

### DISCLOSURES

The authors have no conflicts of interest to declare.

### CONSENT

Informed consent from the patient in this manuscript for publication was obtain.

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FIGURES

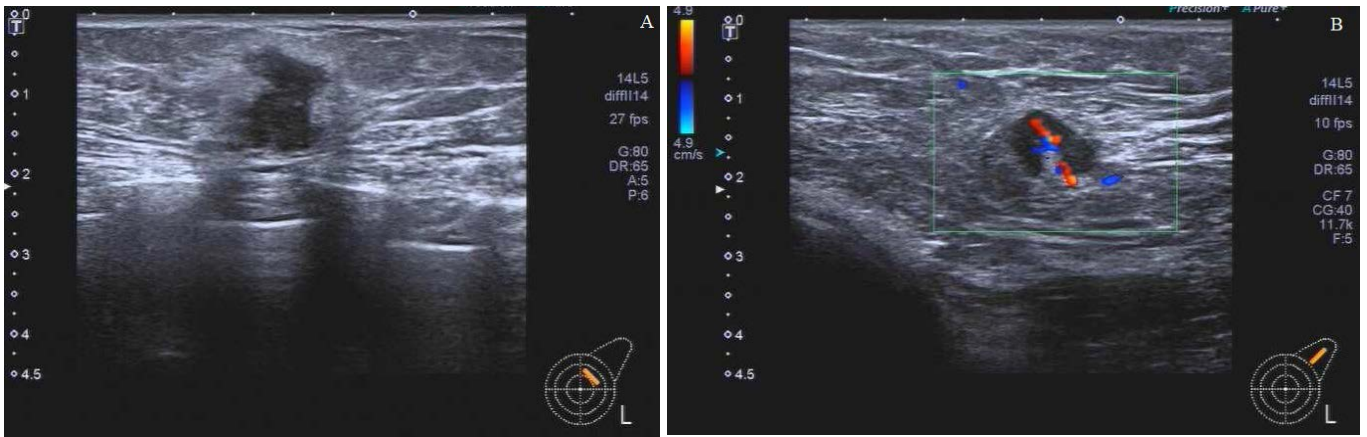


Figure 1: A 59-year-old female with lipid-rich carcinoma in the left breast.

A) Ultrasonography showed a hypoechoic mass with a clear boundary, irregular shape, and distal enhancement. B) Enlarged lymph nodes in the axillary region.

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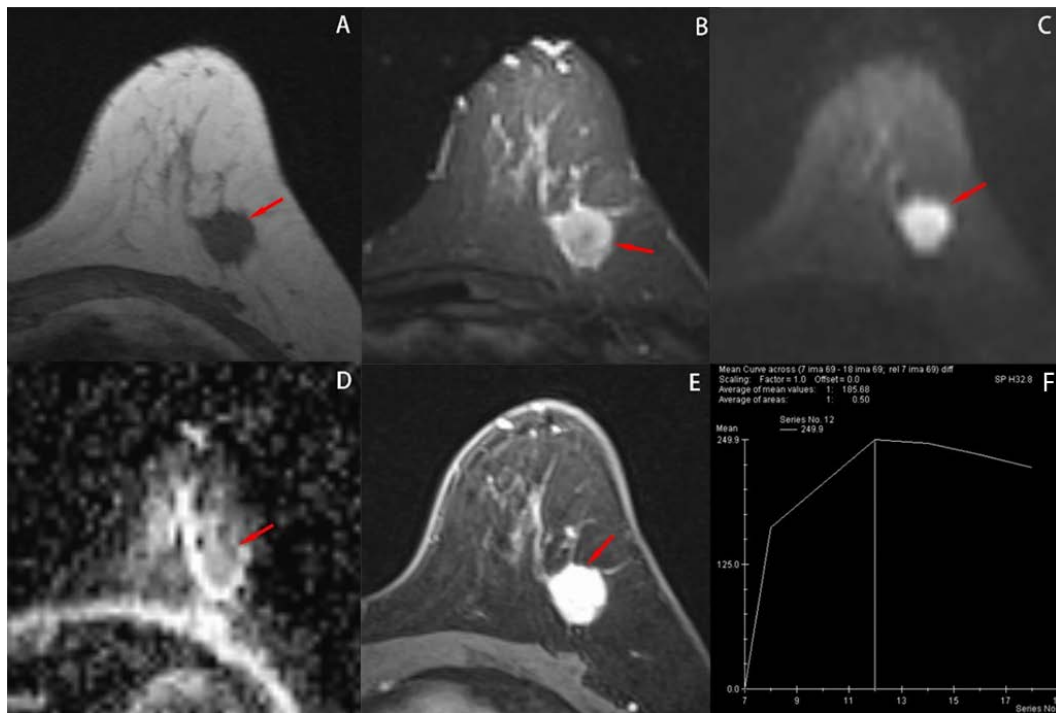
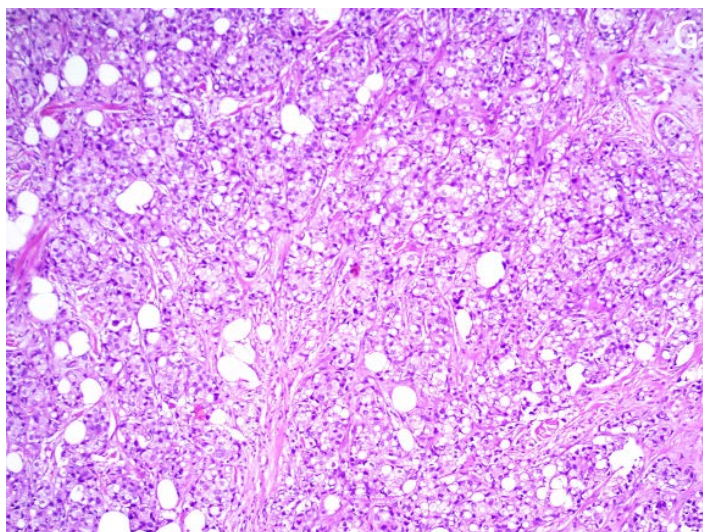


Figure 2: A 59-year-old female with lipid-rich carcinoma.

**Technique:** A) T1-weighted, B) T2-weighted, C) diffusion-weighted imaging (DWI), D) apparent diffusion coefficient (ADC), E)T1-weighted Post-Contrast STIR F) time-signal intensity curves.

**Findings:** MR features was described as above. These images show a round, lobulated, solid mass with smooth borders in the left breast, T1w isointense, T2w hyperintense, DWI hyperintense, and ADC hypointense, obviously enhanced with a wash-out tape.



**Figure 3:** A 59-year-old female with lipid-rich carcinoma.

**Technique:** Hematoxylin and eosin staining; magnification, x100

**Findings:** Histological images from a radical mastectomy in the left breast. Atypical large vacuolated cells arranged in clusters.

**TABLES**

**Table 1:** Summary table for lipid-rich carcinoma

<b>Etiology</b>	unknown
<b>Incidence</b>	a proportion of <1~1.6% among invasive breast cancers
<b>Age predilection</b>	occurs in all age groups, ranging from 10 to 81 years
<b>Gender ratio</b>	Most cases are female; two cases were reported in males.
<b>Risk factors</b>	unknown
<b>Treatments</b>	Radical surgery and systemic treatments are frequently used clinically. Endocrine therapy has a limited effect. Chemotherapy is the most important part of the treatment.
<b>Prognosis</b>	LRC has a poor prognosis. LRC frequency has lymph node metastasis at the time of surgery, and some patients develop distant metastasis in the follow-up, with very poor 5-year survival rates.
<b>Finding on imaging</b>	MRI: a round and lobulated shape with smooth borders, high signal intensity on FS-T2WI and DWI, low ADC values, obvious and homogeneous enhancement, the time signal intensity curves show a washout tape.

**Table 2:** Differential diagnosis table for lipid-rich carcinoma in MRI

Disease	T1WI	T2WI	DWI	Enhancement	Time-signal intensity curves
Lipid-rich carcinoma	Isointense	Hyperintense	Restriction	Obvious, homogeneous enhancing	Wash out tape
Fibroadenomas	Isointense	Hyperintense	Slightly restriction	Gradually enhancing	Plateau or persistent tape
Invasive duct carcinoma	Isointense	Hyperintense	Restriction	Diffusely or peripheral	Wash out tape
Mucinous carcinoma	Hypointense or isointense	Extremely hyperintense	No restriction	Gradually enhancing	Plateau or persistent tape

**KEYWORDS**

Lipid-rich carcinoma; Breast cancer; Malignant; MRI

**ABBREVIATIONS**

LRC = Lipid-Rich Carcinoma  
IDC = Invasive Duct Carcinoma  
T1WI = T1-Weighted Images  
FS-T2WI = Fat-Saturated T2-Weighted Images  
DWI = Diffusion-Weighted Imaging  
ADC= Apparent Diffusion Coefficient  
Her-2 = Human Epidermal Growth Factor Receptor Type 2  
ER = Estrogen Receptor  
PR = Progesterone Receptor  
TIC = Time–Signal Intensity Curve

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