

Granular Cell Tumor of the Breast: A Case Report and a Brief Review of the Literature

Jennifer Paz ², Anthony Shams ², Nathaniel Ball ³, Sierra Wolfe ², Oscar Ramos ², Jessica Jahoda ^{1, 4} and Mohamed Aziz ^{1, 5, *}

¹ Research Writing & Publication (RWP), LLC, NY, USA.

² American University of the Caribbean, AUC, St. Maarten.

³ St. George's University School of Medicine, Grenada.

⁴ Memorial Healthcare System, Pembroke Pines, FL, USA.

⁵ Saint Vincent's Medical Center, New York City, NY, USA.

World Journal of Biology Pharmacy and Health Sciences, 2026, 25(02), 142-149

Publication history: Received on 20 December 2025; revised on 03 February 2026; accepted on 05 February 2026

Article DOI: <https://doi.org/10.30574/wjbphs.2026.25.2.0095>

Abstract

Granular cell tumor (GCT) of the breast is a rare, typically benign neoplasm of Schwann cell origin, which frequently presents a significant diagnostic challenge due to its ability to clinically and radiologically mimic invasive breast carcinoma. We present the case of a 45-year-old female who presented with a palpable, firm, non-mobile mass in the right upper inner quadrant of her breast. Diagnostic imaging was highly suspicious for malignancy, with mammography revealing a high-density, spiculated, irregular mass with architectural distortion (BI-RADS 5), and ultrasound demonstrating an irregular, hypoechoic mass with severe posterior acoustic shadowing and a "taller-than-wide" orientation. Core needle biopsy was performed due to the high suspicion of malignancy. Histopathological examination revealed nests and sheets of large, polygonal cells with abundant granular, eosinophilic cytoplasm. Immunohistochemistry (IHC) studies were critical for definitive diagnosis, showing strong positivity for S100 protein and SOX10, and granular positivity for CD68, while being negative for cytokeratin markers (AE1/AE3, CAM 5.2). This immunoprofiling confirmed the diagnosis of benign GCT. The patient was successfully treated with complete surgical excision (R0 resection) and has remained free of local recurrence at three years of follow-up. This case underscores the critical role of tissue diagnosis and characteristic IHC in differentiating this rare benign entity from malignant breast lesions, thereby preventing unnecessary aggressive treatment.

Keywords: Granular cell tumor; Schwann cell; Benign; Mimics Immunohistochemistry; Infiltration

1. Introduction

Granular cell tumor (GCT) of the breast is an uncommon, typically benign neoplasm that originates from Schwann cells of the peripheral nervous system. [1] Although GCTs may arise in a wide range of anatomic locations, involvement of the breast is particularly rare, accounting for approximately 5%–8% of all granular cell tumors and less than 0.1% of breast tumors [2] Despite their generally indolent behavior, breast GCTs pose a significant diagnostic challenge, as they are well known for clinically and radiologically mimicking invasive breast carcinoma. [3]

On physical examination, GCTs of the breast are commonly palpable as firm, painless, and relatively fixed masses with limited mobility. These features often raise concern for aggressive malignancies, most notably invasive ductal carcinoma. Diagnostic complexity is further compounded by imaging findings, which frequently reinforce suspicion of malignancy. Mammography typically demonstrates a high-density, spiculated mass with architectural distortion, while ultrasonography often reveals a hypoechoic lesion associated with posterior acoustic shadowing. [4] Such

* Corresponding author: Mohamed Aziz.

characteristics frequently result in a BI-RADS category 5 assessment, indicating a high likelihood of malignancy and necessitating prompt tissue biopsy.

Given the potential for misleading clinical and radiologic appearances, the definitive diagnosis of breast GCT relies on histopathologic examination supplemented by immunohistochemical analysis. Histologically, GCTs are composed of nests and sheets of large, polygonal cells with abundant, finely granular, eosinophilic cytoplasm. Immunohistochemistry is essential to distinguish GCTs from other granular cell-containing neoplasms, such as oncocytic or apocrine carcinomas. GCTs consistently demonstrate diffuse positivity for neural markers, including S100 and SOX10, and lack epithelial markers such as cytokeratins, which are characteristic of carcinomas. [5]

Once diagnosed, the treatment of choice for breast GCT is complete surgical excision with negative margins. Although the vast majority of GCTs are benign, malignant behavior has been reported in fewer than 1%–2% of cases. In such instances, malignancy is determined based on established histopathologic criteria, including increased mitotic activity and necrosis, underscoring the importance of careful pathologic evaluation. [6] The present case report describes a 45-year-old woman whose clinical and radiologic presentation closely simulated breast malignancy.

2. Case presentation

2.1. Clinical Presentation

A 45-year-old female visited her primary care doctor after finding a hard, painless lump in her right breast during self-examination four months ago. Initially, she explained it by ordinary fibrocystic changes and put off medical care. Nonetheless, her fear grew, and she decided to seek medical attention. Physical examination revealed a 2.2 cm hard, irregular, and non-mobile mass in her right breast, upper inner quadrant (UIQ). The suspicious physical examination led to a referral to the breast surgery clinic. Diagnostic imaging was ordered as soon as possible to define the lesion further and rule out the possibility of malignancy, since the clinical impression was of major concern about the possible carcinoma of the breast.

2.2. History and Physical Examination

The patient started menstruation at the age of 12, and her menstrual cycles were regular. Her two full-term pregnancies were at the ages of 28 and 31 years, with six months of breastfeeding each. She had no chest wall radiation, hormone replacement therapy, or oral contraceptives for more than five years during her twenties and thirties. Her health record was unremarkable with no previous breast biopsies or breast-related concerns. She consumed alcohol in moderation (2-3 drinks per week) and had never smoked. She had an average lifetime risk of breast cancer, which was assessed using her Gail model risk assessment. Her maternal aunt had breast cancer that was diagnosed at the age of 58 (estrogen receptor-positive, postmenopausal). None of the other family members had breast, ovarian, or other BRCA-related malignancies. The genetic counseling assessment concluded that she was not eligible for a germline test.

On physical examination, vital signs were unremarkable. Examination of the breast showed a 2.2 cm, hard, indurated mass in the right breast UIQ, at 5 cm from the nipple. The mass was ill-defined, with irregular borders and limited mobility, suggesting potential fixation to the chest wall or parenchyma. No skin alterations, no nipple retractions, or peau d'orange were present. There was no bilateral axillary, supraclavicular, or infraclavicular lymphadenopathy. Left breast examination was unremarkable. The rest of the physical examination, including the cardiopulmonary and abdominal examinations, did not reveal any abnormality.

2.3. Radiographic Studies

Digital mammography showed a high-density, spiculated, irregular mass in the right breast, UIQ lesion presented with spiculation and architectural distortion with extension into the surrounding parenchyma. Associated calcifications were not identified. The mass was poorly defined with features highly suspicious of malignancy. Contralateral breast revealed scattered non-suspicious fibroglandular densities. The mammography BI-RADS was 5 (highly suggestive of malignancy; necessitating prompt tissue biopsy). Specific ultrasound of the right breast revealed a 2.2 x 1.8 x 1.9 cm irregular, hypoechoic mass with poorly defined margins, severe posterior acoustic shadowing, and high vascularity on color Doppler imaging. The mass was taller than it was wide, suggesting a vertical orientation. No echogenic halo was observed, and internal heterogeneity was noted. No cysts, both simple and complex, were detected. Right axillary ultrasound showed unremarkable nodes with intact fatty hilum and no cortical thickening.

The radiological features were suggestive of invasive ductal carcinoma as the most likely diagnosis. The spiculated margins, architectural distortion, posterior acoustic shadowing, and BI-RADS 5 classification were very indicative of

malignancy. Other possibilities included invasive lobular carcinoma, but the mass-like appearance was more consistent with ductal carcinoma. Benign masses such as radial scar, fat necrosis, or diabetic mastopathy were considered less likely based on the images. Sclerosing adenosis and post-traumatic changes would fall under the broader differential but were considered unlikely due to clinical history and radiography.

2.4. Tumor Board Management Discussion

The case was discussed in the multidisciplinary breast tumor board. It was strongly agreed that the case showed malignancy (BI-RADS 5) and should have a tissue diagnosis. The group discussed two alternatives, including image-guided core needle biopsy and direct surgical excision. Since there was a high level of suspicion of cancer, core needle biopsy was advised as the first stage of determining a histological diagnosis, receptor status, and grade, which would proceed to discuss neoadjuvant versus adjuvant therapy options in identifying malignancy. An ultrasound-guided core needle biopsy was performed, and a few core samples (14-gauge core biopsy) were obtained from different parts of the mass. Core biopsy samples consisted of a series of tan-gray, firm-tissue fragments measuring 1.5 cm. The tissue was solid without necrosis or cystic alteration.

2.5. Tissue Diagnosis

The initial microscopic analysis showed abnormal morphology, which could not be termed as typical carcinoma. The tissue also exhibited layers of cells with large, richly granular cytoplasm, which was more likely to be granular cell tumors and less likely to be carcinoma. The histological sections demonstrated nests and sheets of large, polygonal cells with abundant, finely granular, eosinophilic cytoplasm. The cells were uniform with centrally placed, small nuclei showing slight pleomorphism and rare mitotic figures. The tumor cells had spread through the breast ducts and lobules into the adjacent adipose tissues and fibrous stroma. Notably, the epidermal pseudoepithelial hyperplasia, which is typical of cutaneous GCT, was absent in this breast site. None of the necrosis, high nuclear atypia, or high mitotic activity (characteristics of malignant GCT) was detected. (Figure 1 A, B, C)

The differential diagnosis was histiocytic lesions, oncocytic carcinoma, apocrine carcinoma with granular cytoplasm, metastatic renal cell carcinoma, and alveolar soft part sarcoma. The cytomorphology and invasive growth pattern required immunohistochemical examination to make a conclusive diagnosis.

On IHC, the tumor cells were strongly and diffusely positive for S100 protein, which indicates neural origin, and for SOX10. The cytoplasmic positivity for CD68 (PGM1) was granular, indicative of lysosomal accumulation. (Figure 1 D, E) The cells were cytokeratin negative (AE1/AE3, CAM 5.2), ruling out carcinoma; negative for HMB-45 and Melan-A, ruling out melanoma; negative for desmin and SMA, ruling out myogenic tumors; and negative for CD31 and CD34, ruling out vascular lesions. A granular cell tumor (GCT) was diagnosed based on the immunoprofile (S100+/CD68+/SOX10/cytokeratin-negative). Molecular testing was not required for the diagnosis. The benign histological appearance, the lack of worrisome criteria (necrosis, more than two mitoses per 10 high-power fields, and prominent pleomorphism), and the typical immunophenotype allowed the diagnosis of benign granular cell tumor of the breast.

2.6. Treatment, Outcome, and Follow-up

Since the definitive diagnosis had already been established, the standard treatment of a granular cell tumor was suggested to be a complete surgical excision with negative margins. The patient underwent surgery to get the mass removed and preserve the breast tissue. The excised tumor was solid, gray-white, and infiltrative and measured 2.3 cm. A frozen section confirmed the diagnosis of granular cell tumor. Final pathology showed total excision with a 5 mm margin, indicating an R0 resection. No axillary surgery was conducted because granular cell tumors hardly spread to lymph nodes. The patient had uneventful surgery and did not require postoperative therapy.

The patient received counseling regarding the diagnosis, its benign nature, the low recurrence rate with complete removal, and the fact that it may rarely change malignantly. She was put on surveillance, whereby she had clinical breast examinations every six months, then once a year. Routine mammographic screening was performed annually.

The patient did not show any symptoms or clinical or radiographic signs of local recurrence three years after diagnosis. The right upper inner quadrant of the breast showed changes on mammography annually after surgery, with no suspicious findings. She had an excellent cosmetic result and was fully satisfied with the breast-conserving technique—no new lesions on the breast appeared bilaterally. The patient proceeded with regular screening in terms of breast cancer screening and followed up regularly with the breast surgery.

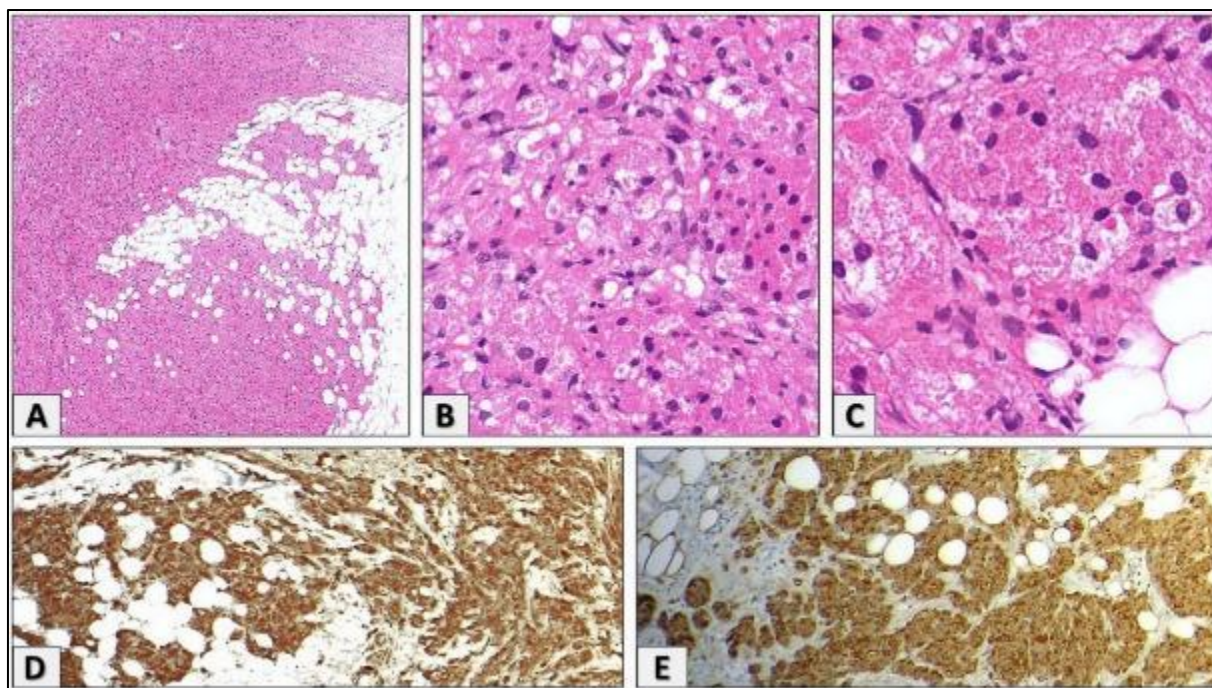


Figure 1 Microscopic examination of the excised granular cell tumor (GCT)

1A: Low power view showing an ill-defined solid tumor infiltrating the breast fibrofatty tissue (H&E X20); 1B: Intermediate power view showing nests and sheets of large, polygonal cells with an excessive amount of eosinophilic, finely granular cytoplasm (H&E X40); 1C: High power view showing uniform, centrally placed, small nuclei displaying slight pleomorphism and rare mitotic figures (H&E X60); 1D: Tumor cells positive for CD68; 1E: Tumor cells positive for S100

3. Discussion

3.1. Background (History, epidemiology, risk factors, and WHO classification):

Some rare, benign breast lesions can closely resemble invasive carcinoma on both physical exam and imaging. A definitive diagnosis, therefore, requires microscopic evaluation and IHC studies. One of these lesions is the GCT of the breast. [2]

First described by Russian pathologist Abrikossoff in 1926, breast GCTs are benign and exceedingly rare, constituting only about 0.03% of all tumors. [7] Initially termed "granular cell myoblastoma" due to a presumed muscle origin, modern IHC and electron microscopy have since established that these tumors arise from Schwann cells. [8]

Although GCTs most commonly occur in the head and neck, only about 15% are found in the breast. [9] Within the breast, they typically present in the upper inner quadrant, unlike invasive ductal carcinoma, which most often affects the upper outer quadrant of the breast. [7] [10] The World Health Organization classifies GCTs as uncommon soft tissue tumors, with malignant transformation being very rare (approximately 0.5–2.0% of cases). [2] [11]

Overall, GCTs can develop throughout the body, with the tongue being the most frequent site (40–65%). Breast GCTs represent only 5–8% of all granular cell tumors and less than 0.1% of all breast tumors. [12] They show a strong female predominance (~7:1 ratio), most commonly occurring in women aged 40–60, with African Americans at higher risk. [8] While most breast GCTs are solitary (90%), 5–10% of patients may present with multiple tumors in various locations. [2] [8]

Given the significant clinical and radiographic overlap with invasive carcinoma, accurate diagnosis of breast GCT relies on thorough microscopic and IHC analysis, and sometimes molecular studies. [13] Recognizing this benign entity is critical to preventing unnecessarily aggressive treatment.

3.2. Pathogenesis, pathophysiology

GCTs of the breast are uncommon neoplasms with a well-established neuroectodermal origin, arising from Schwann cells of peripheral nerves within the intralobular breast stroma. [11] Although historically debated as myogenic in origin, contemporary immunohistochemical and ultrastructural studies have confirmed Schwannian differentiation, supported by consistent diffuse positivity for S100 protein and SOX10, as well as morphologic features characteristic of neural lineage. [12] [14] These findings have resolved earlier controversies regarding tumor histogenesis.

At the molecular level, recent studies have identified inactivation of vacuolar H⁺-ATPase (V-ATPase) accessory genes, most commonly *ATP6AP1* and *ATP6AP2*, as a key driver of GCT pathogenesis. [15] [16] Loss-of-function mutations in these genes impair acidification of endolysosomal compartments, disrupting normal autophagic and lysosomal degradation pathways. As a result, undigested cellular material accumulates within secondary lysosomes and autophagic vacuoles, producing the characteristic abundant eosinophilic granular cytoplasm. [15] These granules are typically PAS-positive and diastase-resistant, reflecting lysosomal overload rather than histiocytic differentiation, a finding further supported by frequent CD68 positivity. [16]

Unlike many neoplasms, GCTs generally lack consistent chromosomal aberrations or oncogenic signaling alterations, [17] which may explain their predominantly benign biological behavior. In the breast, GCTs most often arise in association with intramammary nerves and grow slowly, with a locally infiltrative pattern rather than distant metastatic spread. [16] [17]

Their interaction with surrounding tissue largely defines the pathophysiology of breast GCTs. Although typically benign and non-encapsulated, these tumors grow in nests and sheets that infiltrate adjacent fibrofatty stroma and entrap Cooper's ligaments. [12] This infiltrative growth pattern leads to clinical and radiologic features that closely mimic invasive carcinoma, including firm masses with indistinct or spiculated margins, posterior acoustic shadowing, and occasional skin dimpling or nipple retraction due to stromal fibrosis. [18] Malignant transformation is rare, occurring in fewer than 2% of cases, and is determined by established histopathologic criteria rather than specific molecular biomarkers. [19] [20]

3.3. Comparative analysis of our case with the existing literature. (Clinical-radiology-pathology, lab, diagnosis, management, and outcome)

The clinical and radiological presentation of this case is highly characteristic of the diagnostic dilemma posed by breast GCTs in the existing literature. [4] [22] Clinically, GCTs typically present as solitary, firm, painless masses, often in the upper inner quadrant, which is consistent with the location of the mass in our patient. [23] Radiologically, the tumor's features, a spiculated, irregular mass on mammography and an ill-defined, hypoechoic mass with marked posterior acoustic shadowing on ultrasound, are classically associated with invasive ductal carcinoma (IDC). [4] [24] The assignment of a BI-RADS 5 category in our case, indicating a high probability of malignancy, is a common finding in the literature, reflecting the tumor's infiltrative growth pattern that mimics malignant desmoplastic reaction. [25]

Pathologically, however, our case aligns perfectly with the established features of benign GCT. The microscopic finding of large, polygonal cells with abundant eosinophilic, granular cytoplasm is the histological hallmark of this tumor. [26] The definitive distinction from malignant mimics, such as apocrine carcinoma or metastatic renal cell carcinoma, was achieved through IHC. The strong and diffuse positivity for S100 protein and SOX10, confirming the Schwann cell origin, coupled with granular positivity for CD68 and negativity for epithelial markers (Cytokeratin AE1/AE3) and melanoma markers (HMB-45, Melan-A), is the classic immunophenotype for GCT. [4] [26] These contrasts sharply with IDC, which would be cytokeratin-positive and S100-negative. Furthermore, the absence of high-grade features (necrosis, high mitotic rate, prominent pleomorphism) confirmed the benign nature, consistent with the vast majority of reported breast GCTs. [4]

In terms of management and outcome, our approach of complete surgical excision with negative margins (R0 resection) is the standard of care for benign GCT. [23] The decision to forgo axillary lymph node dissection was appropriate, as GCTs rarely metastasize to lymph nodes. The excellent long-term outcome, with no recurrence at three years, mirrors the favorable prognosis reported in the literature following complete excision of benign GCTs. [4] This case thus serves as a textbook example of a benign GCT that presents as a radiological malignancy, highlighting the indispensable role of core biopsy and IHC in guiding appropriate, breast-conserving management.

4. What have we learned from this case?

This case provides a valuable educational opportunity, reinforcing several key lessons in breast pathology and oncology. The primary lesson is the critical importance of maintaining a broad differential diagnosis for highly suspicious breast masses, even those classified as BI-RADS 5. GCT must be considered in the differential, as its clinical and radiological features are notoriously deceptive, often leading to an initial misdiagnosis of carcinoma. [4] [24] The case underscores that the definitive diagnosis rests solely on tissue sampling. Furthermore, it highlights the indispensable role of a comprehensive immunohistochemical panel, particularly S100 protein, SOX10, and cytokeratin markers, in accurately distinguishing this rare, neural-derived tumor from a common, malignant epithelial tumor. [26] Finally, the case confirms that once a benign GCT diagnosis is established, a conservative approach of complete surgical excision with negative margins is curative, preventing the patient from undergoing the unnecessary morbidity associated with more aggressive cancer treatments like chemotherapy or extensive axillary surgery.

Abbreviations

Granular cell tumor (GCT); Immunohistochemistry (IHC); Upper inner quadrant (UIQ)

5. Conclusion

We report a case of breast GCT that perfectly illustrates the diagnostic pitfall of this rare entity. The primary reason for reporting this case is to enhance awareness within the medical community, particularly among radiologists, surgeons, and pathologists, regarding the characteristic yet highly deceptive presentation of GCT. The case serves as a powerful reminder that a BI-RADS 5 classification, while highly suggestive of malignancy, does not preclude a benign diagnosis. By detailing the classic radiological mimicry of carcinoma and the definitive role of the S100+/SOX10+/Cytokeratin-immunophenotype, this report provides a practical guide for the accurate diagnosis of GCT. Ultimately, the correct pre-operative diagnosis via core biopsy and IHC is paramount, as it dictates a shift from a potentially aggressive cancer management pathway to a curative, breast-conserving surgical excision, thereby benefiting patient care and preventing overtreatment.

Compliance with ethical standards

Acknowledgments

Special thanks to Jennifer C. Ejeh, Idanys Albanes, Luigi Colangelo, and Nelson Chang Tsang for their assistance in reviewing the final manuscript. Additionally, we appreciate the assistance of Grammarly's language editor and the Claude Sonnet 4.5 program, which provided valuable writing support by identifying and correcting errors in grammar, spelling, punctuation, and writing style, ultimately enhancing the manuscript.

Disclosure of conflict of interest

All authors make the following declarations:

- Payment/services information: All authors have declared that they received no financial support from any organization for the submitted work.
- Financial relationships: All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might be interested in the submitted work.

Statement of ethical approval

Ethical review and approval were not required for this study involving human participants. The paper has been sufficiently anonymized to maintain the patient's confidentiality.

Data access statement

All relevant data are included in the paper.

Author contributions

All authors contributed equally to producing this manuscript.

Statement of informed consent

This study was conducted as a retrospective review of archival pathology material collected during routine clinical care. All data were fully de-identified prior to analysis. No patient contact or intervention was involved, and informed consent was not required in accordance with institutional policies.

References

- [1] Flauto, Francesco, et al. "Malignant Granular Cell Tumor of Chest Wall: A Case Report." *Frontiers in Oncology*, vol. 14, 2024, doi:10.3389/fonc.2024.1465130.
- [2] Ismail, Ahmed A., et al. "Granular Cell Tumor of Breast: A Case Report and Literature Review." *Indian Journal of Pathology and Oncology*, vol. 12, no. 4, 2025, pp. 377-382.
- [3] Abreu, Natacha, et al. "Granular Cell Tumor of the Breast: Correlations Between Imaging and Pathology Findings." *Radiologia Brasileira*, vol. 53, no. 2, 2020, pp. 105-111.
- [4] Eddin, Assim Saad, et al. "Breast Granular Cell Tumor: A Case Report and Review of Literature." *Radiology Case Reports*, vol. 19, no. 10, 2024, pp. 4358-4362.
- [5] Husnara, Bibi, and Joseph Daniel. "Granular Cell Tumor of Breast Mimicking Malignancy: A Series of Six Cases." *Journal of Clinical and Diagnostic Research*, vol. 19, no. 10, 2025.
- [6] Galloway, Catherine. "Granular Cell Tumor of the Male Breast: A Case Report and Review of the Literature." *Annals of Breast Surgery*, 2024, doi:10.21037/abs-23-45.
- [7] Lakhtakia, Ritu. "A brief history of breast cancer: Part I: Surgical domination reinvented." *Sultan Qaboos University Medical Journal* 14.2 (2014): e166.
- [8] Al-Balas M, De Leo A, Serra M, Santini D, Taffurelli M. Granular cell tumour of the breast: a rare presentation of a breast mass in an elderly female with a subsequent breast cancer diagnosis. *SAGE Open Medical Case Reports*. 2019 Apr;7:2050313X19841154.
- [9] Hammas et al. Hammas N, El Fatemi H, Jayi S, et al. Granular cell tumor of the breast: a case report. *J Med Case Reports*. 2020;14(1):145.
- [10] Filipovski V, Banev S, Janevska V. Granular cell tumor of the breast: a case report and review of the literature. *Cases J*. 2009;2:8551.
- [11] Daniel Neelon; Ford Lannan; John Childs. Granular cell tumor. StatPearls [Internet]. Accessed on February 02, 2026. <https://www.ncbi.nlm.nih.gov/books/NBK563150/>
- [12] Luceno S, Biernacka A. Granular cell tumor. PathologyOutlines.com website. <https://www.pathologyoutlines.com/topic/breastgct.html>. Accessed January 31st, 2026.
- [13] Pujani M, Jain M, Chauhan V, Singh SK, Agarwal C, Suryanarayan P, et al. Granular cell tumor of the breast: a diagnostic dilemma. *J Cancer Res Ther*. 2020;16(6):1517-20.
- [14] Mukai et al. Mukai M, Torikata C, Iri H, et al. Expression of S100 protein in granular cell tumors. *Hum Pathol*. 1994;25(1):11-16.
- [15] Pareja et al. Pareja F, Brandes AH, Basili T, et al. Loss-of-function mutations in ATP6AP1 and ATP6AP2 in granular cell tumors. *Nat Commun*. 2018;9(1):3533.
- [16] Rogala P, Czarnecka AM, Sobczuk P, Szumera-Ciećkiewicz A, Rutkowski P, Szostakowska-Rodzios M, et al. Molecular and immunohistochemical characterization of granular cell tumors. *Virchows Arch*. 2022;480(3):575-85.
- [17] Rosa M. Advances in the molecular analysis of breast cancer: pathway toward personalized medicine. *Cancer Control*. 2015 Apr;22(2):211-9.
- [18] Sekar et al. Sekar V, Luthra R, Kanagal-Shamanna R. Genomic profiling of malignant granular cell tumors. *Cureus*. 2023;15(4):e37210.
- [19] Bosmans J, Weyler J, Paridaens R. Granular cell tumor of the breast: a rare mimic of breast carcinoma. *Breast J*. 2021;27(4):357-9.

- [20] Nasser H, Ahmed Y, Szpunar SM, Kowalski PJ. Malignant granular cell tumor: a look into the diagnostic criteria. *Pathol Res Pract*. 2011;207(3):164-8.
- [21] Eddin AS, Ramzan U, Hsieh SK, Policeni F. Breast granular cell tumor: A case report and review of literature. *Radiology case reports*. 2024 Oct 1;19(10):4358-62.
- [22] Taghi-Zadeh E, Choudhury MS, Shaar M, Singh E. Breast Granular Cell Tumor. Radiopedia case. (Accessed on 01 Feb 2026) <https://cdn.agilitycms.com/applied-radiology/publishhub/AR-54-4-0094/AR-D-25-0094.pdf>
- [23] Rexeena B, Paul A, Nitish RA, Kurian C, Anila RK. Granular cell tumor of breast: A case report and review of literature. *Indian journal of surgical oncology*. 2015 Dec;6(4):446-8.
- [24] Zeng Q, Liu L, Wen Q, Hu L, Zhong L, Zhou Y. Imaging features of granular cell tumor in the breast: Case report. *Medicine*. 2020 Nov 20;99(47):e23264.
- [25] Radswiki T, Knipe H, Weerakkody Y, et al. Granular cell tumor of the breast. Reference article, Radiopaedia.org (Accessed on 01 Feb 2026) <https://doi.org/10.53347/rID-14932>
- [26] Brown AC, Audisio RA, Regitnig P. Granular cell tumor of the breast. *Surgical oncology*. 2011 Jun 1;20(2):97-105.