REVIEW ARTICLES

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Microwave Ablation for Granulomatous Lobular Mastitis: A Narrative Review

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Granulomatous lobular mastitis (GLM) is a rare, chronic, and benign inflammatory breast disease predominantly affecting women of reproductive age. It is clinically characterized by breast masses, pain, erythema, and the potential development of abscesses and fistulas. The etiology remains complex, involving autoimmune responses, bacterial infections, and hormonal imbalances. Currently, there is no standardized consensus on the optimal management of GLM. Conventional treatment modalities, including systemic corticosteroids, immunosuppressants, and surgical excision, are frequently constrained by elevated recurrence rates, poor aesthetic outcomes, and severe systemic adverse effects. Consequently, there is an urgent clinical need for alternative, minimally invasive interventions. Microwave ablation (MWA) has emerged as a novel therapeutic approach that utilizes electromagnetic energy to induce localized coagulative necrosis of pathological tissues. This narrative review synthesizes recent clinical research to evaluate the potential efficacy and safety of MWA for treating GLM. Current preliminary evidence suggests that ultrasound-guided MWA may reduce the recurrence rate of GLM while achieving promising clinical and pathological remission rates. Furthermore, compared to traditional surgical and pharmacological therapies, MWA may offer advantages, including the preservation of breast tissue, improved cosmetic outcomes, reduced postoperative complications, and shorter recovery times. However, it is crucial to note that the current evidence base is limited by a small number of predominantly retrospective studies, a lack of long-term comparative data, and limited geographic diversity. Despite the necessity for specialized equipment, advanced operator expertise, and careful patient selection, MWA may serve as a promising and well-tolerated treatment option for managing GLM.

Keywords: Mastitis • Microwaves • Therapeutics

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Introduction

Granulomatous lobular mastitis (GLM) was first described by Kessler and Wolloch [1] in 1972. GLM is a rare, chronic, benign inflammatory disease predominantly affecting women of reproductive age who have recently given birth and nursed within the past 5 years [2]. GLM is characterized by non-caseating granulomatous inflammation within the lobules of the breast, accompanied by numerous infiltrates of inflammatory cells [3]. Clinically, most patients initially exhibit a breast mass, while others may demonstrate an inflammatory response characterized by erythema, edema, warmth, and pain. As the disease advances, individuals may develop additional subcutaneous or deep abscesses, as well as fistulas and sinus tract development [4].

GLM is considered a rare disease globally; however, an increasing number of cases have been reported in China, which may reflect heightened clinical recognition, improved diagnostic capabilities, or changes in referral patterns rather than a true rise in incidence [5]. It is important to note that throughout the existing literature, this distinct benign inflammatory breast condition is variously referred to as idiopathic granulomatous mastitis, GLM, or simply granulomatous mastitis. While individual cited studies may favor different nomenclatures based on specific pathological or clinical emphasis, these terms generally represent the same disease entity. For the purpose of clarity and consistency, the term GLM will be used uniformly throughout this review. The disease shows a high recurrence rate, significantly affecting patients' quality of life. The challenge lies in the absence of a standardized treatment for GLM, along with inherent limits and shortcomings in conservative and surgical approaches.

Microwave ablation (MWA) technology has been utilized for primary or secondary diseases in various anatomical regions, including the liver, kidney, lung, breast, adrenal gland, and bone [6-10]. The principle is to position the electrode around the tumor under ultrasound assistance. The electromagnetic waves produced by the electrode will excite water molecules, causing the electric charge on the molecules to oscillate up to 2 billion times per second, thereby generating heat through friction, ultimately resulting in coagulative necrosis of the cells to achieve the therapeutic effect [11,12].

Due to the rarity of GLM, prior literature has primarily focused on conventional pharmacological and surgical management, leaving the specific role of MWA therapy relatively underexplored. In recent years, an increasing number of scholars and surgeons have concentrated their efforts in this topic, resulting in a series of preliminary but largely fragmented publications. Consequently, there is a growing need for a dedicated review to synthesize these scattered data. Several unresolved clinical questions remain, particularly regarding optimal patient selection, long-term efficacy, and how MWA compares with conventional therapies. Unlike previous broad reviews on overall GLM management, this narrative review focuses specifically on MWA. We aim to help address the current knowledge gap by critically appraising the available evidence, exploring technical considerations, and providing a balanced perspective on the potential benefits and limitations of MWA in treating GLM.

Methods

Literature Search Strategy

To ensure a comprehensive and transparent review of the literature, a structured search strategy was used. We comprehensively searched the PubMed database for articles published from January 1, 2015, to January 1, 2025. The primary search terms used, individually and in combination through Boolean operators (AND, OR), included "granulomatous lobular mastitis", "idiopathic granulomatous mastitis", "granulomatous mastitis", and "microwave ablation". In addition, the reference lists of the retrieved articles were manually screened to identify any further relevant studies. (Note: Foundational historical literature regarding disease definition was included for background context).

Study Selection Criteria

Articles were considered for inclusion if they met the following criteria: (1) studies evaluating the clinical application, technical principles, efficacy, or safety of MWA in patients diagnosed with GLM; (2) peer-reviewed original research, including prospective and retrospective observational studies, case series, and foundational studies on GLM etiology and conventional treatments; and (3) articles published primarily in English. Studies were excluded if they lacked relevance to GLM or MWA, focused exclusively on other benign breast tumors (eg, fibroadenomas) without a distinct GLM cohort, or were conference abstracts lacking full-text availability. Following an initial screening of titles and abstracts, the full texts of potentially relevant articles were thoroughly reviewed, critically appraised, and synthesized for this narrative review.

Overview of GLM

Etiology and Pathophysiology

The pathophysiology of GLM is delineated by 3 predominant hypotheses: the autoimmune hypothesis, the bacterial infection hypothesis, and the hormonal disorder theory, with the autoimmune hypothesis being the most frequently endorsed [13].

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Prior retrospective studies have demonstrated diffuse positive expression of CD3, CD4, CD8, and CD79a cells in GLM lesions [14]. A recent study by Saydam et al observed increased levels of IL-17 and IL-22 in patients with GLM [15]. Moreover, from the standpoint of symptomatic management, immunosuppressive therapy utilizing steroids in conjunction with methotrexate is highly effective in reducing the recurrence rate of GLM and enhancing therapeutic efficiency [16]. The bacterial infection hypothesis posits that *Corynebacterium* may contribute to the etiology of GLM. Taylor et al examined tissue samples from 62 patients with GLM and identified *Corynebacterium* infection in 34 of these cases [17]. The hormonal disorder hypothesis posits that hyperprolactinemia significantly contributes to the etiology of GLM. Li and McGregor documented a case of GLM in a patient with hyperprolactinemia resulting from extended use of risperidone, which was effectively treated with bromocriptine for hyperprolactinemia [18]. This indicates that hyperprolactinemia, which causes illness, may act as a catalyst for GLM.

When examined under a microscope, GLM is distinguished by granulomatous inflammation that occurs around the lobular units of the breast and may be accompanied by microscopic abscesses. Infiltration of diverse inflammatory cells, such as neutrophils, monocytes, lymphocytes, epithelioid cells, and multinucleated giant cells, is observed within the lobules [19]. Precise identification of the pathological characteristics of GLM is essential for diagnosing the condition and identifying breast cancer.

Clinical Presentations and Diagnostic Criteria of GLM

A systematic study involving 3060 patients with GLM indicated that the average age of onset was 36 years old, with 80% of patients initially presenting with a palpable breast lump, 66% of which were accompanied by pain [20]. As the condition advances, patients may develop subcutaneous microabscesses, ulcers, abscess chambers, and the creation of sinus tracts and fistulas. A survey of 474 patients with GLM identified additional clinical manifestations, including nipple discharge, nipple retraction, skin lesions such as edema and erythema, and arthralgia [21].

The clinical diagnosis of GLM is complicated by its unclear pathophysiology and the variability of clinical manifestations. The primary diagnostic technique presently employed is pathological investigation using hollow-core needle aspiration. In addition, ultrasound and magnetic resonance imaging can be used as imaging aids for diagnosis. Ultrasound typically reveals GLM as heterogeneous hypoechoic masses exhibiting irregular morphology and indistinct borders, potentially accompanied by tubular extensions [22], whereas MRI often depicts the lesions as nonuniform enhancing masses with indistinct borders and blurred margins. A thorough diagnosis of GLM can be achieved by integrating laboratory tests, including immunologic assays, inflammatory markers, and hormone levels.

Contemporary Therapies and Their Constraints

GLM lacks a defined therapy, which can be classified into 2 primary categories: conservative and surgical. Conservative interventions encompass antibacterial therapy, steroid therapy, and immunosuppressive therapy. A recent meta-analysis of GLM treatment recurrence rates revealed that oral steroids had a recurrence incidence of 24%, topical steroids, 11%; antibiotics, 18%; and methotrexate, 13%. A recurrence rate of 4% was attained via the administration of steroids in conjunction with methotrexate, the most recommended conservative treatment for granulomatous mastitis [16].

The statistics indicate a high recurrence incidence of the disease following monotherapy, making it challenging to attain optimal therapeutic outcomes. The administration of steroids necessitates a precise understanding of the principle of the shortest treatment duration and optimal dosage; yet, there is currently an absence of standardized guidelines for dosage and administration methods. An insufficient treatment duration or dosage can result in relapse and rebound effects, whereas excessive dosage and prolonged treatment can cause mood fluctuations, hypertension, diabetes, muscle atrophy, osteoporosis, heightened infection risk, Cushing's syndrome, and various other complications [23,24]. This presents an enormous challenge for doctors and is sometimes difficult for patients to accept.

Conservative treatment is mostly suitable for people with smaller lesions, whereas surgical intervention is the preferred option for complex cases, including extensive lesions with sinus tract and fistula development. The prevailing surgical intervention is contingent upon the lesion's magnitude, employing simple excision and drainage for localized masses, whereas big lesions necessitate stage clearance, extended clearance, or mastectomy [2]. Nonetheless, the biggest drawback of surgical intervention is the unsatisfactory aesthetic outcome, which makes surgery difficult for many patients to accept. Furthermore, postoperative complications include nipple inversion, delayed healing, discomfort, hematoma, mammary fistula, persistent infection, and skin flap gangrene [25]. Consequently, there is an immediate necessity for a therapeutic approach characterized by a low recurrence rate, great efficacy, and minimal comorbidities.

Principles of MWA Therapy

Overview of MWA Technology

MWA technology has attained greater sophistication in the treatment of several diseases. In recent years, the implementation

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and thorough investigation of MWA technologies in breast surgery departments have yielded significant and positive outcomes in the treatment of various solid benign breast conditions. However, it is crucial to emphasize that while these data establish the technical plausibility and general safety of MWA within breast tissue, they should not be extrapolated as equivalent clinical evidence for GLM. Unlike well-circumscribed solid tumors, GLM presents a complex, diffuse inflammatory pathology that requires specific clinical validation. The fundamental mechanism of MWA is the use of microwave electromagnetic fields to generate rapid vibrations in water molecules, protein molecules, and other polar molecules within the affected tissue. This vigorous molecular movement results in numerous collisions and friction, producing elevated temperatures ranging from 60 to 150 °C in the localized area. This shift in temperature ultimately results in coagulative necrosis of the tissue, producing therapeutic effects [26].

MWA offers several significant advantages over traditional surgical procedures. It substantially shortens the procedure's duration and greatly improves the aesthetic outcome of the breast after surgery, while simultaneously decreasing the risk of postoperative complications. This method can efficiently treat many lesions in a single session, and the procedure is usually performed under local anesthesia, thereby improving treatment convenience and patient comfort. It also presents numerous notable advantages over radiofrequency ablation [27]. The necrotic volume produced in the ablation zone is larger, the coagulation margin is more uniform and refined, and the heat dissipation is comparatively less, hence demonstrating enhanced therapeutic potential [28,29].

Procedure of MWA Therapy

Prior to the surgery, the patient has an extensive series of examinations to confirm the diagnosis and identify any pertinent contraindications. Additionally, the number, location, size, form, and vascularity of the lesions are meticulously assessed using ultrasonography. Based on the findings, an optimum individualized ablation procedure is designed. The procedure must encompass, but not be restricted to, essential details such as the site and depth of puncture, ablation duration, and the necessity for abscess aspiration. The MWA therapy device (KY2000, Nanjing Kangyou Medical Technology Co, Nanjing, China) operates at a frequency of 2450 MHz [29]. Prior to the start of surgery, the patient was positioned either supine or laterally, and the puncture site was sterilized and subjected to local anesthesia. An isolation solution, typically comprising saline, 1% lidocaine, and 2% ropivacaine injection, was administered around the lesion tissue prior to the procedure to safeguard the adjacent skin and other tissues [30]. Thereafter, under ultrasound guidance, the needle was inserted at the predetermined entrance position. During the ablation procedure, 35 W of power may be used for the central region of the lesion, while 25 W of power may be used for the peripheral region of the lesion. For minor abscesses, the fixed-point ablation technique is applicable; for several or bigger lesions, the multipoint multi-stage mobile ablation technique is used, with the entire ablation process conducted under real-time ultrasound monitoring [31,32]. Ablation is deemed complete when the entire lesion region is noted to exhibit hypoechoicity. Ultimately, the patient may receive a local dressing and an ice pack to conclude the ablation process.

Patient Selection

Patient selection is key to the efficacy and safety of MWA in treating GLM. Based on clinical evidence, suitable candidates for MWA include patients presenting with localized, circumscribed mass-stage or early abscess-stage GLM. MWA also serves as an alternative option for patients experiencing disease recurrence following conventional surgery, those intolerant to the adverse effects of prolonged corticosteroid therapy, and patients who prioritize the preservation of breast cosmesis.

Conversely, specific GLM phenotypes are less suitable for upfront MWA. Patients with diffuse inflammatory lesions encompassing multiple breast quadrants, or lesions located adjacent to the skin or nipple-areolar complex, face a higher risk of incomplete ablation or thermal skin injuries (eg, burns, ulceration, or fistula formation). Furthermore, MWA is contraindicated when concurrent breast malignancy cannot be ruled out via core needle biopsy, or in patients with coagulation disorders and major organ insufficiencies.

Within the GLM treatment pathway, MWA can be utilized as a primary treatment for small, localized disease. For larger, diffuse, or active inflammatory lesions, MWA is often considered as a secondary intervention following a partial response to medical therapy. In these cases, a preliminary course of systemic corticosteroids is frequently administered to downstage the disease—reducing the surrounding inflammatory edema and shrinking the lesion volume. This pharmacological downstaging creates a smaller target for subsequent MWA, improving the complete ablation rate while minimizing collateral thermal damage to healthy breast tissue (**Figure 1**).

Microwave Ablation Therapy in GLM

Emerging clinical data from clinical research and case analyses suggest that MWA may serve as a promising, breast-conserving alternative to conventional treatments for carefully selected patients with GLM. However, to fully understand its clinical value, it is essential to objectively evaluate the current evidence, which predominantly consists of retrospective studies with varying sample sizes and follow-up durations. A retrospective cross-sectional study by Lin et al [2] evaluated

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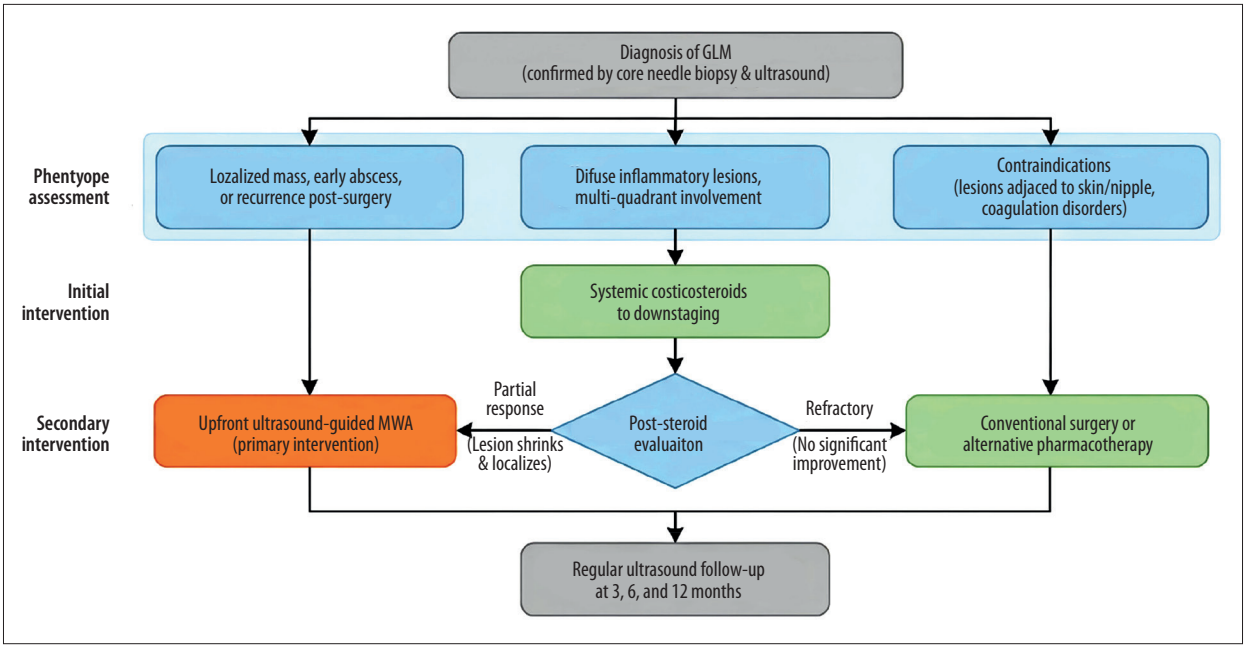

Figure 1. Proposed clinical algorithm for the management of granulomatous lobular mastitis (GLM).

50 patients with GLM treated with MWA combined with a short course of oral corticosteroids. Over a follow-up period of 12 to 15 months, the study reported a combined clinical and pathological remission rate of 98% (78% cured within 12 months and 20% within 15 months) and a recurrence rate of 2%. In this study, complete remission was confirmed through both ultrasound evaluation and follow-up core needle biopsies; however, the lack of a control group limits comparative conclusions. Another retrospective cohort study, conducted by Li H et al [31], compared MWA (n = 91) to extended surgical excision (n = 143), with both groups receiving preoperative prednisone. Over a 1- to 2-year follow-up, the MWA group achieved a clinical remission rate of 97.8% and a complete remission rate (defined as no lesion on ultrasound and pathologically confirmed absence of typical features) of 96.7%, alongside a low recurrence rate of 3.3%. The average duration for complete remission among patients was approximately 10.8 months, and the overall incidence of postoperative complications was 5.5%. While these results suggest MWA is a viable and less invasive alternative to surgery, the retrospective design may introduce inherent selection bias.

Additional retrospective series have also reported exceptionally high efficacy rates, although these outcomes should be interpreted in the context of their specific evaluation criteria. For instance, Zhou S et al [30] reported a 100% overall effective rate in a subgroup of 29 patients treated with MWA alone over a median follow-up of 6 months. This overall rate encompassed a 34.48% complete cure rate and a 65.52% partial response (apparent effect). Similarly, a retrospective study by Zhou Y et al [32] reported a 100% overall efficacy rate for a sub-cohort of 22 patients with GLM, with an average hospitalization duration of 6.2 days, a metric that also combined complete recovery and partial improvement.

While the current literature (**Table 1**) demonstrates the potential and safety of MWA for treating GLM, several methodological limitations within the existing evidence base should be acknowledged. First, it is important to note that the definitions of clinical outcomes—such as clinical cure, complete remission, and efficacy rate—vary across studies and lack standardized criteria. Second, the uniformly high success rates reported in current literature suggest a potential risk of publication bias, which may lead to an overestimation of treatment efficacy. The reliance on retrospective designs, relatively small sample sizes, and the absence of large-scale randomized controlled trials limit the ability to draw definitive conclusions regarding MWA's absolute superiority over standard care. Furthermore, considering the complex and diffuse inflammatory microenvironment of GLM, long-term tissue healing and recurrence dynamics require extended observation. The findings of these studies suggest that MWA therapy offers a promising, minimally invasive option with favorable cosmetic outcomes for carefully selected patients. Nevertheless, these preliminary benefits require further rigorous validation through multi-center, prospective controlled trials with standardized outcome measures.

Safety and Complications of MWA

Mild-to-moderate treatable complications can occur after MWA therapy. Among these, pain is most frequent; nevertheless, in most patients, pain is mild to moderate and resolves

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Table 1. Summary of included clinical studies evaluating microwave ablation (MWA) for granulomatous lobular mastitis (GLM).

Study parameters	Lin et al (2021) [2]	Li et al (2024) [31]	Zhou S et al (2023) [30]	Zhou Y et al (2021) [32]
Country	China	China	China	China
Study design	Retrospective cross-sectional study	Retrospective cohort study	Retrospective analysis	Retrospective observational study
Sample size	MWA + oral prednisone (n = 50)	MWA (n = 91); Surgery (n = 143) (Both received oral prednisone)	Total n = 53 (MWA alone: n = 29; MWA + incision/drainage: n = 24)	Total n = 53 (GLM sub-cohort: n = 22, plasma cell mastitis sub-cohort: n = 31)
Follow-up duration	12-15 months	12-24 months	Median 6 months (range 3-12)	12 months
Comparator	None	Extended surgical excision	MWA alone vs MWA + incision and drainage	None
Remission/efficacy rate	98% Clinical and pathological remission rate (78% within 12 months, 20% within 15 months)	MWA: Complete remission 96.7% Clinical remission 97.8%; Surgery: Complete 86.7% Clinical 97.9%	MWA alone: 100% "overall effective" (34.48% cure, 65.52% partial response)	Overall effective rate 98.1% (GLM sub-cohort effective rate 100%)
Recurrence rate	2%	MWA: 3.3%; Surgery: 13.3%	0% during short-term follow-up	Overall 1.9% (0% in GLM sub-cohort, 1.9% in plasma cell mastitis sub-cohort)
Complications	Mild & manageable (local pain 76%, skin heat injury 2%, fat liquefaction 8%, sinus drainage 40%)	MWA overall 5.5% (skin heat injury 2.2%, fat liquefaction 1.1%, sinus tract 1.1%, ulceration 1.1%)	MWA alone: New sinus (27.59%), fat liquefaction (3.45%)	Minimal (postoperative liquefaction drained by puncture needle)
Cosmetic outcomes	96% Patient satisfaction; appearance and texture returned to normal without visible scars	BREAST-Q satisfaction scores significantly higher in MWA group (78.7 ± 6.9) vs surgery (63.9 ± 7.7)	MWA alone: 79.31% Excellent, 20.69% Good MWA + drainage: 45.83% excellent	Harris score: 71.7% Excellent, 26.4% Good (overall 98.1% favorable appearance)

spontaneously without the need for specific therapy [31]. Furthermore, dermal burns can occur due to heat transfer and are usually alleviated by the application of ice packs. Additionally, fat liquefaction can occur but can be alleviated with suction drainage. Patients can also have the formation of sinus tracts [2], accompanied by the draining of necrotic tissue, which typically resolves spontaneously following sinus drainage. Other potential consequences include subcutaneous hematomas and dermal ulcers, which are typically alleviated by simple interventions.

Comparison With Conventional Treatment Methods

It is essential to acknowledge that treatment selection in GLM is highly individualized and heavily influenced by disease severity, lesion complexity, the presence of abscess or sinus formation, patient preference, and local expertise. Rather than replacing traditional methods across all settings, MWA serves as a complementary or alternative option for specifically selected patients (**Table 2**).

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Table 2. Comparison of microwave ablation (MWA) and conventional treatment modalities for granulomatous lobular mastitis (GLM).

Treatment Modality	Description and efficacy	Primary advantages	Key disadvantages and limitations	Cosmetic outcomes
Observation	Expectant management; spontaneous resolution may occur in some cases without intervention	Avoids pharmacological adverse effects and surgical trauma	Long recovery process; risk of disease progression (eg, enlarged lesions, abscesses, skin ulcers, sinus tracts)	Prolonged unhealed inflammation may lead to spontaneous changes in breast appearance and texture
Systemic steroids	Oral corticosteroid therapy (eg, prednisone) used to control the inflammatory response	Rapidly reduces inflammatory edema and shrinks mass size	Potential drug resistance; high recurrence rate upon tapering; systemic adverse effects (weight gain, osteoporosis, elevated blood glucose)	Avoids surgical tissue loss, though unhealed fistulas or ulcers may leave spontaneous scars
Local steroids	Intralesional steroid injections to achieve localized anti-inflammatory effects	Mitigates the severe systemic adverse effects associated with oral glucocorticoids	Recurrence rate remains a challenge; necessitates repeated treatments and long-term management	Avoids surgical excision and structural breast deformity
Methotrexate	Immunosuppressive therapy used for prolonged periods (often > 1 year) to achieve disease remission	Effective for controlling refractory symptoms (pain, erythema, edema) in complex cases	Extended treatment duration; heightened infection risk; associated with unavoidable hematological or hepatic adverse effects	Prevents surgery-induced breast deformities, but final appearance depends on underlying disease severity
Surgical excision	Interventions ranging from abscess incision and drainage to extended mammary lesion resection	Definitive physical removal of the intact lesion, affected skin, and necrotic tissues	Requires general anesthesia; risk of postoperative wound complications (eg, incision hematoma, delayed healing)	Destructive to breast function and cosmetic appearance; high risk of breast deformation, nipple deformation, and scar hyperplasia
Combined approaches	A preliminary course of medical therapy (eg, steroids) followed by surgery or MWA	Pharmacological downstaging significantly reduces inflammatory edema and primary lesion volume	Prolonged overall treatment timeline; requires coordination of multiple therapeutic modalities	Creates a smaller target for subsequent intervention, thereby minimizing collateral damage to healthy breast tissue
Microwave ablation (MWA)	Ultrasound-guided thermal ablation that induces localized coagulative necrosis of lesion tissues	Typically performed under local anesthesia; shorter operation and recovery times; low recurrence rate	Requires specialized equipment and advanced operator expertise; contraindicated in patients with unruled-out malignancy or severe coagulation disorders	Preserves a greater amount of healthy breast tissue; maintains breast contour without large visible surgical scars

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While surgical excision remains a definitive and preferred option for complex cases involving extensive lesions or severe sinus tracts, MWA is a minimally invasive alternative for localized disease. It typically requires only local anesthesia and a minor needle puncture, resulting in a shorter postoperative recovery time. MWA is notably advantageous, as it preserves a greater amount of healthy breast tissue, resulting in reduced harm to the overall breast shape and cosmetic appearance, which is an advantage over conventional surgical lesion excision.

Compared with systemic glucocorticoid medication, MWA therapy can help mitigate numerous adverse effects associated with prolonged steroid use, including weight gain, osteoporosis, and increased blood glucose levels. Hormone therapy necessitates an extended treatment duration, is susceptible to lengthy recovery, and greatly impacts patients' physical and mental well-being. Although some studies employ localized hormone injections in lieu of systemic glucocorticoids to mitigate systemic adverse effects, the disease's recurrence rate remains a challenge, necessitating additional treatment and management [34]. By swiftly reducing or eradicating localized lesions, MWA can significantly enhance patient confidence in a cure.

Although methotrexate immunosuppressive therapy demonstrates efficacy, and most patients can achieve disease remission after over 1 year of continuous treatment (accompanied by notable alleviation of symptoms such as pain, erythema, edema, and induration) [35], the prolonged use of this immunosuppressive therapy is associated with unavoidable adverse effects, heightened infection risk, and an extended treatment duration, which is difficult for patients to adhere to. Moreover, alternative therapies such as rifampicin treatment [36] and bromocriptine for hyperprolactinemia [37] are infrequently utilized in clinical practice due to the constraints of their specific pathogenesis, including *Corynebacterium* infections [38] and the coexistence of hyperprolactinemia [39].

Conclusions

In summary, while MWA may not be universally superior across all clinical scenarios, it offers a highly advantageous, minimally invasive alternative that avoids the substantial tissue loss of surgery and the systemic burden of prolonged pharmacotherapy in appropriately selected candidates.

This review evaluates the clinical application and technical aspects of MWA for treating GLM. Current evidence indicates that MWA is a promising, minimally invasive treatment option that can provide satisfactory remission rates and preserve breast cosmesis, especially for carefully selected patients managed in experienced medical centers. However, the existing literature is limited, as it is derived primarily from small, retrospective, and non-randomized studies.

While MWA presents a viable alternative to conventional surgery and prolonged pharmacotherapy, generalized claims of its superiority are currently unsupported. Future research must prioritize large-scale, prospective controlled trials to determine long-term efficacy, standardize outcome definitions, and optimize patient selection criteria before MWA can be universally adopted as a standard of care.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Department and Institution Where Work Was Done

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Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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