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Sexual function outcome in erbium-doped yttrium aluminum garnet laser versus topical estrogen among postmenopausal patients: a systematic review

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Abstract

Genitourinary syndrome of menopause (GSM) is a symptom affecting both the urinary tract and vagina due to decreased sex hormones, especially estrogen, during menopause. This study aims to compare the efficacy of vaginal erbium-doped yttrium aluminum garnet (Er-YAG) laser therapy and topical estrogen treatment in managing GSM. A systematic literature search was conducted following PRISMA guidelines, utilizing electronic databases. The databases searched included PubMed, Scopus, Google Scholar, and the Cochrane Library. Clinical trials are included that evaluate GSM patients treated with vaginal Er-Yag laser therapy. All studies were assessed for risk of bias using the Newcastle-Ottawa scale. Among 695 studies in the initial search, only three cohorts are eligible in this review, representing the analysis of 546 patients across the globe. Our analysis shows vaginal dryness and dyspareunia significantly decreased (60% asymptomatic for dyspareunia, 30% for dryness at 12 months; VAS for dryness/dyspareunia decreased from 8.3/8.5 to 5.6/5.3 at 12 months). Vaginal health indicators also improved: the vaginal health index score increased (10.6 to 16.5), maturation value significantly increased (20.8 to 52.2; median 5 to 80), vaginal pH decreased, and sexual satisfaction (e.g., orgasm frequency p=0.007) in the laser group compared to the estrogen group. Compelling evidence shows the efficacy of Er-YAG laser therapy in improving sexual function outcomes and alleviating symptoms associated with GSM more than topical estrogen therapy.

Key words: erbium-doped yttrium aluminum garnet laser, genitourinary syndrome of menopause, sexual satisfaction, FSFI.

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Introduction

Genitourinary syndrome of menopause (GSM) affects approximately 50% of postmenopausal women, characterized by hypoestrogenism-induced thinning of the vaginal epithelium, reduced elastin and collagen, also elevated vaginal pH.[1,2] Common symptoms include vaginal dryness, dyspareunia, pruritus, urinary incontinence, and recurrent urinary tract infections, which significantly impair quality of life (QoL) and mental health.[2,3] Unlike some menopausal symptoms that lessen over time, GSM typically worsens without treatment. The progressive nature of GSM underscores the need for effective long-term management strategies to alleviate these debilitating symptoms.[4]

Current treatment for GSM encompasses hormonal and non-hormonal therapies. Topical estrogen such as estriol and estradiol remains the gold standard. It demonstrates efficacy in restoring vaginal health.[5,6] However, concerns including systemic absorption, thromboembolic risks, and low adherence rates (52-74%) limit its use, particularly in breast cancer survivors or women with contraindications to hormonal therapy.[2,6,7] Non-hormonal therapies such as moisturizers, hyaluronic acid, and selective estrogen receptor modulators (*e.g.*, ospemifene) offer symptomatic relief; however, they lack the restorative effects of estrogen.[8,9] Emerging therapies, such as vaginal laser treatment using fractional CO2 and erbium-doped yttrium aluminum garnet (Er-YAG) lasers, have shown a benefit by promoting tissue repair through collagen synthesis and neovascularization.[10-12]

Vaginal laser therapy, particularly with the Er-YAG laser, presents as a promising alternative for patients with contraindications to or a preference against hormonal treatment. The Er-YAG laser works through photothermic action, promoting collagen remodeling and tissue tightening. Systematic reviews highlight short-term improvements in vaginal health index (VHI) and symptom relief with CO2 and Er-YAG lasers, though methodological limitations and heterogeneity across studies persist.[13-15] Notably, Er-YAG laser has demonstrated superior safety and precision in targeting atrophic tissues without thermal damage.[16,17]

However, comparative studies evaluating the Er-YAG laser and topical estrogen are still a few, and existing data do not yet support routine recommendations by Food and Drug Administration.[2] Therefore, this study aims to compare the

efficacy of vaginal Er-YAG laser therapy and topical estrogen treatment in managing sexual function outcome among post-menopausal women.

Methods

Searching strategy

A literature search was conducted based on the PRISMA guidelines across databases such as PubMed, the Cochrane Library, and Scopus.[18] The authors used a blend of MeSH terms and keywords for a thorough search. Key words included "genitourinary syndrome of menopause", "Laser Er-YAG", "topical estrogen", "sexual function", and related synonyms as presented in Table 1.

Study selection

This study recruited the following inclusion criteria: articles in English published from the databases' inception to July 2025, recruiting female patients with GSM, and evaluating the sexual function as the outcome based on female sexual function index (FSFI), vaginal analog scale (VAS), or urogenital distress inventory scores. The studies were excluded whether they were not published in English, solely focused on animal models or *in vitro* experiments, had an irretrievable full-text, or not indexed studies in Scopus. Subsequently, all relevant articles were organized using Mendeley Reference Manager, which was employed to automatically and manually eliminate duplicate records. The final collection of articles was then exported to Microsoft Excel for screening based on title and abstract, followed by a meticulous examination of the full text. During the selection procedure, any disputes were resolved through discussion and mutual agreement among authors.

Data extraction

The authors extracted data from the literature by recording information such as publication year, study design, participant demographics, intervention groups, detailed descriptions of the intervention and control protocols, outcomes, and follow-up period. The research team conducted the extraction independently to ensure consistency and accuracy in the collated data. In cases where disagreements happened during the screening or data extraction process, the authors (RST, EA) resolved them through mutual discussion. A third independent author (BIS) served as an arbitrator and made the final decision if a consensus could not be reached.

Assessment of risk of bias

The authors independently evaluated the quality of the research papers using distinct tools, the Newcastle-Ottawa scale (NOS) for observational studies.[19] The NOS employed three criteria to assess observational studies: sample selection, study comparability, and study result, encompassing eight items with scores ranging from 0 to 9. Scores within the ranges of 0-3, 4-6, and 7-9 correspond to poor, moderate, and high-quality studies, respectively. In case of any disagreements between the two authors (RST, EA) during the assessment process, they were resolved through expert opinion (BIS) and consensus.

Results

The initial search yielded 698 potential articles; after excluding duplicates, 690 unique articles remained. Afterwards, 90 articles had relevant titles and abstracts and only 10 were available for full-text access. After screening based on eligibility and exclusive criteria, three records were eligible for qualitative synthesis in this study. Figure 1 presents the comprehensive literature search strategy and screening process. Table 2 shows the characteristics of the included studies. All the included studies were high-quality articles according to NOS scores (Table 3), which represented the robust methodology and results of each study.

This systematic review included three studies that compared the Er-YAG laser with topical estrogen therapy. The studies were published between 2017 and 2025, representing global locations worldwide. A total of 546 patients were included across all studies, with sample sizes ranging from 50 to 254 patients per study. All of the studies were cohort studies (two prospective and one retrospective).

Patient characteristics

The patient populations across the three studies primarily consisted of postmenopausal women, with mean ages generally ranging from the mid-40s to early 60s. For instance, Gambacciani *et al.* reported a mean age of 61.2±7.2 years for the laser group and 62.0±7.5 years for the control group.[20] Gaspar *et al.* had similar age ranges, with the laser group averaging 55.0±6.7 years and the control group 53.5±5.7 years.[21] Qi *et al.* included a younger cohort, with mean ages of 45.36±4.98 years for the laser group and 44.32±3.43 years for the estrogen group, indicating that GSM symptoms could affect a broader age spectrum.[22]

Regarding sample sizes, there was considerable variability. Gambacciani *et al*. included a large laser group of 205 patients, while Qi *et al*. had 130 patients in the laser group and 112 in the estrogen group.[20] Gaspar *et al.* employed a more balanced design, with 25 patients in each of the laser and control groups.[21]

Table 1. Full electronic search strategy for electronic databases.

Database	Keywords	Hits
PubMed	(genitourinary syndrome of menopause) AND (Er Yag laser) AND (Topical estrogen) AND (Sexual Function)	7
Scopus	((genitourinary AND syndrome AND menopause) AND ((Er-Yag AND laser) AND (topical AND estrogen) AND (sexual AND function)	13
Google Scholar	(genitourinary syndrome of menopause) AND (Er Yag laser) AND (Topical estrogen) AND (Sexual Function)	674
Cochrane	#1: genitourinary syndrome of menopause #2: Er-Yag laser #3: Topical estrogen #4: Sexual Function #1 AND #2 AND #3 AND #4	1

Table 2. Summary of study results.

Study	Location	Study design	Mean age (y)	Intervention group (n)	Control group (n)	GSM diagnosis criteria	Intervention protocol	Control protocol	Follow-up (mo)	Outcomes
Gaspar *et al.*, 2017[21]	Argentina	Prospective cohort	Laser group: 55.0±6.7, Control group: 53.5±5.7	25	25	Estradiol level <20 pg/ml and at least one GSM symptom.	Type: XS Dynamis, Fotona (2940nm Er:YAG, non-ablative). Duration: 3 sessions, every 3 weeks. Dosage: 1,000-1,500 J total energy.	0.5 mg estriol ovules for 8 weeks.	18	Symptoms (Dyspareunia, Dryness, Irritation, Chronic Leukorrhea): Laser group showed statistically significant (P<0.05) reduction up to 18 months. Estriol group showed significant reduction up to 6 months, then diminished/worsened at 12/18 months. MV: Laser group significantly increased (P<0.001) up to 12 months (20.8 to 52.2). Estriol group improved significantly at 1/3 months, then declined (22.5 to 25 at 12 months, P<0.05). pH: Laser group significant decrease (P<0.001) up to 12 months (5.0 to 4.4). Estriol group decrease less pronounced, diminished at 12 months (4.9 to 4.9). Side effects: Laser (4%): warmth, mild-moderate pain, slight edema, transitory pain (1), spotting (1). Estriol (12%): spotting (8%), mastodynia (4%), abdominal pain (12%).
Gambaccia ni *et al.*, 2018[20]	Italia	Prospective cohort	Laser group: 61.2±7.2, Control group: 62.0±7.5	205	49	Presence of GSM symptoms with postmenopausal hormone levels (FSH >40 U/l; estradiol <25 pg/ml).	Type: XS Fotona Smooth™ (2940nm Er:YAG, non-ablative). Duration: 3 applications, every 30 days. Dosage: 6.0 J/cm^2, 1.6 Hz.	Estriol gel (50 mg) twice weekly for 3 months.	24	Vaginal Dryness (VAS): VEL significant decrease (p<0.01) up to 12 months; returned to baseline by 18/24 months. Dyspareunia (VAS): VEL significant decrease (p<0.01) up to 12 months; returned to baseline by 18/24 months. VHIS: VEL significant increase (p<0.01) up to 12 months; returned to baseline by 24 months. ICIQ-UI SF: VEL significant decrease (p<0.05) up to 12 months. Acceptability/Efficacy: 73.6% effective for 12-18 months. 84.9% decided to repeat. Adverse events: <3% discontinued. No adverse events recorded.
Qi *et al.*, 2025[22]	China	Retrospective cohort	Laser group: 45.36±4.98, Control group: 44.32±3.43	130	112	Presence of GSM symptoms & symptoms of vaginal relaxation and diagnosed vaginal laxity.	Type: IntimaLase, XS Dynamis, Fotona (Er:YAG). Duration: Not specified, 3-month follow-up. Dosage: Vaginal canal: 8-10 J/cm^2; Vestibule/introitus: 10 J/cm^2.	0.5-1 gram of 17ß-estradiol ointment (0.01%) daily for ~2 weeks, then reduced.	3	PFMS (3-month follow-up): Laser group significantly better. Duration (P=0.009), Max pressure (P=0.002), Avg pressure (P=0.046). Vaginal Atrophy Symptoms/Scores (3-month follow-up): Laser group greater improvement. Symptom score (P=0.043), Atrophy score (P=0.035). MFSQ (3-month follow-up): Laser group significantly higher satisfaction: Enjoyment (P=0.032), Freq satisfaction (P=0.041), Partner disinterest (P=0.017, lower), Partner as lover (P=0.031, higher), Orgasm freq (P=0.007). Vaginal Tightness Satisfaction: Laser group significantly better (P=0.001). Lactobacilli Grades (3-month follow-up): Significant difference (P=0.012). Higher Grade 4 in laser (19.23%) vs. estrogen (8.93%). Vaginal pH (3-month follow-up): No significant difference (P=0.498). Adverse Reactions: Overall incidence Laser 11.54% vs. Estrogen 16.7% (P=0.306).

RCT, randomized controlled trial, NA, not available, n, number, mo, months, y, year; GSM, genitourinary syndrome of menopause.

Genitourinary syndrome of menopause diagnosis criteria

The diagnostic criteria for GSM varied among the studies, reflecting a lack of universal standardization in clinical practice. Gambacciani *et al*. employed a more stringent approach, requiring the presence of GSM symptoms in conjunction with postmenopausal hormone levels (Follicle Stimulating Hormone/ FSH>40 U/L; estradiol <25 pg/mL).[20] Gaspar *et al*. also used hormonal criteria (estradiol level <20 pg/mL) in conjunction with at least one GSM symptom.[21] Qi *et al*. focused on symptoms of vaginal relaxation and diagnosed vaginal laxity.[22] This heterogeneity in diagnostic criteria could influence the characteristics of the patient populations included in each study.

Intervention protocol

The Er-YAGlaser intervention protocols showed commonalities in the type of laser used but varied in application specifics. All studies employing laser therapy utilized a 2940 nm Er-YAGnon-ablative laser. However, the number of sessions, duration between sessions, and energy dosages differed. Gambacciani *et al.* applied three sessions, 30 days apart, with a dosage of 6.0 J/cm^2 at 1.6 Hz.[20] Gaspar *et al*. also used three sessions, every 3 weeks, with a total energy of 1000-1500 J.[21] Qi *et al*. used an Er-YAG laser with dosages of 8-10 J/cm^2 for the vaginal canal and 10 J/cm^2 for the vestibule/introitus, but the duration and number of sessions were not specified.[22] These variations underscored the ongoing investigation into optimal laser parameters.

Control protocol

For studies that included a control group receiving topical estrogen, the protocols also varied. Gambacciani *et al*. employed estriol gel (50 mg) twice weekly for 3 months.[20] Gaspar *et al.* used 0.5 mg estriol ovules for 8 weeks. Qi *et al.* utilized 0.5-1 gram of 17ß-estradiol ointment (0.01%) daily for approximately 2 weeks, followed by a reduced frequency.[21] These differences in estrogen type, dosage, and application frequency made direct comparisons between laser and estrogen challenging across all studies.

Outcomes

The outcomes measured across the studies were comprehensive, encompassing both subjective symptom assessments and objective physiological parameters, consistently demonstrating improvements after therapy.

Gaspar *et al*. assessed dryness and dyspareunia using a VAS (0-3 scale), maturation value (MV), and vaginal pH. Before treatment, dryness VAS was 2.24, dyspareunia VAS was 2.44, MV was 20.8, and pH was 5.0. After 18 months, dryness VAS decreased to 1.52 and dyspareunia VAS to 1.60. MV significantly increased to 52.2, and pH decreased to 4.4 after 12 months.[21]

Gambacciani *et al*. measured dryness and dyspareunia using a VAS (0-10 scale) and VHI score (VHIS, 1-25 scale). Before treatment, dryness VAS was 8.3 and dyspareunia VAS was 8.5. After 12 months, these significantly decreased to 5.6 and 5.3, respectively. VHIS increased from 10.6 to 16.5.[20]

Qi *et al*. evaluated vaginal atrophy scores (VAS 1-10) and McCoy female sexuality questionnaire (MFSQ) orgasm frequency. Before treatment, the vaginal atrophy score was 6.85. After 3 months, it decreased to 4.95. MFSQ orgasm frequency increased from 41.07% to 58.46% after 3 months.[22]

Overall, the results consistently indicated that both Er-YAG laser therapy and topical estrogen (where applicable) lead to significant improvements in GSM symptoms and objective vaginal health parameters. The specific metrics and magnitudes of improvement were varied; however, the general trend towards positive outcomes was evident across all included studies.

Follow-up period

The follow-up period was varied considerably among the studies. Gambacciani *et al.* had the longest follow-up at 24 months, providing insights into longer-term effects. Gaspar A, *et al.*

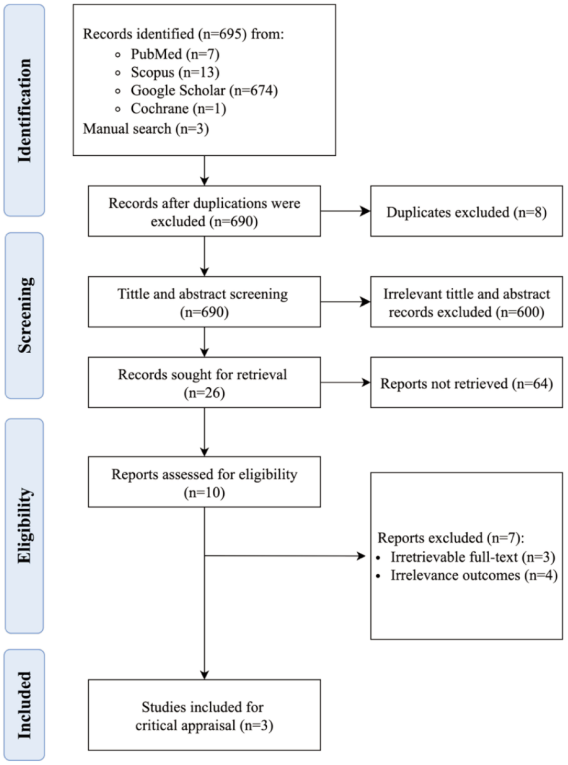

Figure 1. PRISMA flow chart.

Table 3. Newcastle-Ottawa Scale quality assessment of included articles

Reference	Selection (max 4 stars)	Comparability (max 2 stars)	Exposur (max 3 stars)	Total	Interpretation
Gaspar *et al*., 2017;[21]	★★★	★★	★★★	8	Good
Gambaccini *et al*., 2018;[20]	★★★	★★	★★★	8	Good
Qi *et al*., 2025;[22]	★★★	★★	★★	7	Good

Selection: 1) representativeness of intervention cohort; 2) selection of non-intervention cohort; 3) ascertainment of intervention; 4) demonstration that outcome was not present at start of study. Comparability: 1) comparability of cohorts on basis of design or analysis. Outcome: 1) assessment of outcome; 2) enough follow-up time length for outcome to occur; 3) adequacy of follow-up of cohorts.

followed patients for 18 months, and Qi *et al.* had a shorter follow-up of 3 months.[20-22] The variability in follow-up duration can impact the assessment of sustained treatment efficacy and the occurrence of late-onset adverse events.

Risk of bias assessment

The NOS was used to assess the included cohort studies, with scores ranging from 6 to 8 out of 9 possible stars, indicating moderate to high quality (Table 3). The most common methodological limitations included potential selection bias (in retrospective cohorts). Factors such as selection bias, lack of blinding, and incomplete outcome reporting in some studies could affect the reliability of their findings. The relatively short follow-up periods in some studies also limited the understanding of the long-term efficacy and safety of Er-YAG laser therapy for GSM.

Discussion

The studies included in this analysis collectively represented a diverse range of study designs and geographical locations, contributing to a broader understanding of GSM treatment approaches. The mean age of participants across the studies generally ranged from the mid-40s to early 60s, reflecting the typical demographic affected by GSM. Diagnostic criteria for GSM were varied, ranging from the presence of general symptoms to specific hormonal levels and physical examination findings, indicating a lack of universal standardization in diagnosis across the included literature.

Intervention protocols and outcomes

The Er-YAG laser intervention protocols across the studies exhibited some commonalities, primarily utilizing a 2940nm Er-YAG non-ablative laser. However, variations existed in the number of sessions, duration between sessions, and energy dosages. For instance, Gambacciani et al. employed three sessions with different intervals.[20] These differences highlight the evolving nature of laser protocols and the need for further standardization. Another review by Gambacciani *et al.,* including 113,000 patients treated in the past 8 years, revealed that minimally invasive thermal-only laser treatment using the non-ablative erbium laser procedures appears to be safe and the incidence of adverse events is low.[23] The study by Gambacciani *et al.* in 2020 also showed that a large, prospective study of erbium laser treatment may improve sexual function in postmenopausal women suffering from GSM.[24]

Topical estrogen control protocols primarily involved estriol or estradiol, with varying dosages and application frequencies. Gambacciani et al. used estriol gel twice weekly, while Gaspar *et al*. utilized estriol ovules.[20,21] Qi *et al.* employed a 17ß-estradiol ointment with a tapering frequency.[22] The inclusion of topical estrogen as a control or comparison arm in some studies is crucial for evaluating the relative efficacy of laser therapy against a well-established treatment.

The outcomes measured across the studies were comprehensive, encompassing subjective symptom assessments and objective physiological parameters. Common subjective outcomes included vaginal dryness and dyspareunia, often measured using visual analog scales or severity scales. Objective measures included the VHIS, MV, vaginal pH, and, in some cases, pelvic floor muscle strength and specific sexual function questionnaires, such as the MFSQ or FSFI. The consistent reporting of these outcomes allows for a comparative analysis of treatment effects.

Before *versus* after therapy

Across the board, the studies reported significant improvements in GSM symptoms following Er-YAG laser therapy. For instance, Gambacciani *et al*. demonstrated significant decreases in VAS scores for dryness and dyspareunia, alongside an increase in VHIS, indicating improved vaginal health.[20] Gaspar *et al.* corroborated these findings, showing significant reductions in symptoms and positive changes in MV and pH, which suggested a restoration of vaginal tissue health.[21]

Qi *et al.* provided an interesting comparison, showing that the laser group had significantly better outcomes in pelvic floor muscle strength, lower vaginal atrophy scores, and improved sexual satisfaction (*e.g*., orgasm frequency) compared to the estrogen group. This suggested that while both treatments offered benefits, the laser might provide additional advantages in certain aspects of vaginal health and sexual function.[22]

While direct statistical comparisons between laser and topical estrogen were not uniformly available across all studies, the general trend indicated that Er-YAG laser therapy was a promising treatment for GSM, often yielding comparable or even superior results to topical estrogen in specific parameters. The improvements observed in both subjective symptoms and objective physiological markers underscore the efficacy of laser therapy in addressing the multifaceted aspects of GSM.

Strengths and limitations

One of the primary strengths of this review lies in its comprehensive approach to data extraction. By meticulously compiling detailed information on study design, intervention and control protocols, patient demographics (including mean age and sample sizes), GSM diagnostic criteria, and a wide array of outcomes (both subjective and objective, with before-and-after results), the review offers a rich and granular overview of the included studies. This detailed extraction facilitates a deeper understanding of the methodologies employed and the specific effects observed across different research settings.

Furthermore, the inclusion of studies that compare Er-YAG laser therapy with topical estrogen, a well-established treatment for GSM, enhances the clinical relevance of this review. Such comparisons are crucial for clinicians and patients in making informed decisions about treatment options. The review also benefits from incorporating studies with varying follow-up periods, ranging from a few months to over a year, which provides insight into the short- to medium-term durability of the interventions.

Despite its strengths, this systematic review is subject to several limitations, primarily stemming from the characteristics of the included primary studies. A significant limitation is the heterogeneity observed in the study designs and methodologies. The included studies comprise prospective studies, retrospective studies, and comparative cohort studies, which inherently vary in their ability to establish causality and control for confounding factors. This variability makes direct comparisons and meta-analysis challenging.

Another critical limitation is the lack of standardization in Er-YAG laser intervention protocols. Variations in the number of sessions, intervals between sessions, and energy dosages across studies make it difficult to identify an optimal laser treatment regimen. Similarly, the diagnostic criteria for GSM were not uniform across all studies, which could lead to differences in the patient populations studied and potentially influence the reported outcomes.

Finally, the overall quality of evidence, as indicated by the NOS scores, suggests a moderate to high risk of bias in several studies. Factors such as selection bias, lack of blinding, and incomplete outcome reporting in some studies can affect the reliability of their findings. The relatively short follow-up periods in some studies also limit the understanding of the long-term efficacy and safety of Er-YAG laser therapy for GSM. These limitations underscore the need for more rigorous, well-controlled, and standardized research in this field to provide more robust evidence for clinical practice.

Evidence-based recommendations for clinical practice

While direct head-to-head comparisons with topical estrogen were not uniformly available across all studies, the existing data suggest that Er-YAG laser therapy can offer comparable or, in some aspects, superior benefits. Notably, some studies indicated additional advantages of laser therapy in areas like pelvic floor muscle strength and overall sexual satisfaction, positioning it as a valuable alternative or complementary treatment, particularly for women who may have contraindications or preferences against hormonal therapies.

Despite the promising findings, it is crucial to acknowledge the inherent heterogeneity in study designs, laser protocols, and outcome assessments across the reviewed literature. Variations in GSM diagnostic criteria, patient populations, and follow-up durations highlight the need for greater standardization in future research. To further solidify the evidence-based and guide clinical practice, future investigations should prioritize well-designed, adequately powered randomized controlled trials that directly compare Er-YAG laser therapy with various topical estrogen formulations, employing standardized protocols and long-term follow-up periods. Nevertheless, the current body of evidence strongly supports the Er-YAG laser as an effective and safe therapeutic modality in the comprehensive management of GSM, offering significant improvements in the QoL for affected women.

Conclusions

This systematic review provides compelling evidence for the efficacy of Er-YAG laser therapy in improving sexual function outcomes and alleviating symptoms associated with GSM. The consistent positive results observed across various subjective measures, such as reductions in vaginal dryness and dyspareunia, as well as objective physiological markers, including improvements in vaginal pH, MV, and VHIS, underscore the therapeutic potential of this non-ablative laser technology.

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Contributions: Raymond Surya Tan: determining the topic, literature search, appraisal, writing. Ekarini Aryasatiani: literature search, appraisal, commenting. RM Sonny Sasotya: drafting, commenting, crticial revision. Budi Iman Santoso: determining the topic, appraisal, editing.

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