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Application of Laser Therapies in Reducing Atopic Dermatitis Symptoms: A Comparison with Drug Therapies

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ABSTRACT

Background and Objective: Atopic dermatitis (AD) represents a chronic inflammatory skin condition that substantially deteriorates patients' daily functions. Conventional drug treatments, including topical corticosteroids together with biologic agents, help control symptoms, but they may simultaneously present systemic adverse effects as well as affordability barriers. A look at the therapeutic future: Targeted and guided application of therapies such as Excimer and Pulsed Dye lasers, minimizing systemic interactions, has triumphed. This review will provide an analytical comparison between the effectiveness along safety, and patient compliance concerning laser therapy and drug therapy treatment of Atopic dermatitis.

Methods: Systematic research followed the investigation of PubMed, Scopus, and Web of Science databases. Researchers analyzed studies between 2020 and 2024 to determine their relevance using randomized controlled trials and meta-analyses, as well as performing case study evaluations.

Results: The use of laser treatment systems showed remarkable effectiveness for treating localized (AD) conditions, combined with fast symptom control and improved barrier protection outcomes, together with positive treatment caution records. Dupilumab, alongside other biologic drugs, proved more beneficial in treating systemic (AD) by significantly minimizing both chronic itch and disease intensity levels. Lasers had limitations when treating extensive (AD) despite drug therapies presenting risks of general health complications and high costs.

Conclusion: The combination of laser therapy and drug treatment provides effective solutions, although these methods focus on separate therapeutic aspects for (AD) management. Medical care can achieve enhanced disease management and improved patient outcomes by employing an integrative approach that combines both forms of treatment.

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Abbreviations

AD, Atopic dermatitis; LLLT, low-level laser therapy; RCTs, Research that used randomized controlled trials; UVB, Ultraviolet B; IL-4, Interleukin-4; TNF-α, Tumor necrosis factor-alpha; SCORAD, Scoring Atopic Dermatitis; EASI, Eczema Area and Severity Index; TCS, Topical Corticosteroids; PDL, Pulsed dye lasers

Introduction

The chronic inflammatory skin disease atopic dermatitis (AD) affects millions of patients worldwide because it burdens their overall quality through extensive skin problems. The skin condition (AD) produces intense itching alongside repeated eczematous skin outbreaks and unpredictable disease intensity because of combined genetic and immunologic, and environmental factors. The disorder disrupts regular activities and creates extensive emotional and financial expenses, affecting patients together with healthcare institutions. New approaches for treating (AD) expand treatment choices, although they reinforce the persistent difficulty of managing symptoms along with minimizing toxic side effects. The analysis focuses on conventional drug therapies for atopic dermatitis because topical corticosteroids and systemic immunomodulators face weaknesses that affect their effectiveness against severe cases and result in adverse effects and missed doses. Recent advances in medical science have led to the development of dupilumab as a new biologic agent that attacks IL-4 and IL-13 pathways to achieve effective pruritus and inflammation reduction [1]. The medical advancements in therapy show two main restrictions, which consist of expensive treatments alongside extended treatment durations. The field of laser-based therapy has recently emerged as a major research direction to explore new alternative or supporting approaches in (AD) management. The photobiological targeting methods in these interventions act to reduce inflammation while controlling immune responses and improving skin barrier functions. Narrowband UVB, along with excimer lasers and low-level laser therapy (LLLT), provides non-invasive treatment options that deliver localized therapeutic benefits to address (AD) symptoms without forcing patients to experience systemic side effects that traditional drugs can produce. Phototherapy, which includes excimer laser treatments, provides an effective treatment approach for patients with treatment-resistant (AD) and adults and children [2]. The study examines how laser therapeutic methods compare to drug prescription alternatives for treating (AD) symptoms while addressing safety aspects.

This review uses recent clinical and mechanistic studies to explore whether lasers have equivalent benefits or supplementary advantages compared to traditional treatments for sustaining disease control. Treatment effects, along with adverse effect data and patient medication compliance, receive a detailed examination to demonstrate how combining therapies can be successful. Medical practices now include laser therapies as developing therapeutic options that function differently from pharmaceutical medications from a clinical standpoint. Scientists discovered that low-level laser irradiation serves as an effective treatment for (AD) by modifying cytokines while decreasing skin thickness and reducing mast cell numbers in the skin to improve symptoms [3]. High-peak-power Nd: YAG lasers prove effective for managing chronic (AD) beyond standard treatment periods, so they serve as an alternative therapy for (AD) patients who do not respond to conventional approaches. The efficacy of integrating these treatment approaches takes advantage of their separate therapeutic actions that include biologic immunomodulation and laser-induced barrier recovery and anti-inflammatory benefits. When matched together, this method creates new opportunities to transform medical practices for (AD) patients who show resistance to single treatments [4]. This evaluation goes beyond merely summarizing published research to provide an assessment of findings in their therapeutic setting. Research designs an assessment of laser therapy in combination with drug treatments to enable dermatologists to enhance their treatment strategies and improve patient response. The analysis demonstrates the need for evidence-based as well as personalized methods to address the complex nature of this disease.

Methodology

The evaluation uses systematic procedures to analyze laser therapeutics for treating atopic dermatitis symptoms against regular medication treatments. Researchers implemented a thorough methodology that selected appropriate high-quality studies according to the main analysis requirements. The literature search utilized the three research databases of PubMed together with Scopus, and Web of Science.

The chosen databases were selected because they contain vast peer-reviewed medical and scientific literature collections. The research strategy aimed to obtain an all-encompassing dataset that contained relevant materials connected to the investigation area. A search strategy was designed using laser therapy and atopic dermatitis, and drug therapy together with comparison through Boolean operators for keyword combination. The search added synonyms, including "phototherapy" together with "eczema," "biologic therapies," and "light-based interventions," to guarantee the collection of important articles. Search filters were implemented to minimize results to studies in English from 2020 through 2024 that matched the intention of incorporating advanced, high-quality research findings. The selected studies needed to fulfill these requirements as inclusion criteria:

• Research that used randomized controlled trials (RCTs) as well as meta-analyses and case studies with defined methodological approaches was included.

• The studies appeared in high-impact publications that maintain their reputation in academic fields.

• Specifically, the authors examined laser treatments alongside medicinal approaches for managing Atopic dermatitis disease symptoms.

• The selected studies displayed clear outcome data related to their effectiveness and Safety, as well as patient medicine consistency reporting.

• Exclusion criteria encompassed studies that:

• The studies failed to make (AD) and its therapeutic approaches their main focus.

• The research included preclinical studies unless scientists demonstrated clear relevance to therapeutic operations.

• The research lacked appropriate methodological information and failed to undergo a peer review process.

• The analysis only examined economic or policy information, which failed to show clinical results.

The research applied both quantitative and qualitative data evaluation methods to create the findings' synthesis. The author conducted statistical analysis through thematic clustering to detect shared patterns between studies and performed clinical outcomes meta-analyses when available data allowed it. The analysis included statistical techniques that pooled effectiveness results about symptom reduction performance along with quality of life score changes for laser therapy approaches versus medications. Hematological analyses grouped research articles according to laser techniques and types of drugs administered, and study participant attributes, as well as experimental methods. The assessment of study heterogeneity relied on Cochran's Q test together with I^2 statistics to establish systematic methods for handling research variability. The statistical analysis included descriptive outcomes alongside forest plots to display meta-analysis findings.

Laser Therapies

Medical science investigates the potential applications of laser therapy in treating atopic dermatitis through alternative or supportive protocols beyond drug-based treatments. This segment explores the main laser technologies alongside their operational mechanisms, as well as existing evidence about their effectiveness in treating (AD).

3-1- Types of Lasers Used in (AD) Treatment

• The 308-nm Excimer laser demonstrates popularity in dermatology medical settings because it delivers precise 308-nm ultraviolet B (UVB) light. The specific wavelength of this treatment focuses on lesional skin instead of touching healthy tissues, which makes it a superior option for treating localized (AD). The therapeutic approach uses three main actions to decrease cytokines, which cause inflammation, and it helps maintain skin barrier health as well as controls immune system responses. (AD) Patients who do not respond to topical treatments show substantial improvement of their lesions when treated with excimer laser therapy, according to clinical reports [2].

• The Pulsed Dye Laser provides photothermolysis by targeting dilated blood vessels' hemoglobin content. The laser exerts anti-inflammatory effects because it reduces both vascular permeability and inflammatory cytokines in the skin. The PDL treatment method proves successful for managing (AD) skin erythema while it creates an improvement in skin surface quality. A recent medical investigation showed how this treatment eased the redness in the faces of patients with treatment-resistant (AD) while producing minimal adverse reactions [5].

• The fractional CO2 laser maintains its connection to scar treatment in medical practice but also helps (AD) patients by stimulating skin barrier healing while decreasing epidermal tissue growth. The lasers activate collagen reconstruction processes while reducing TEWL, which leads to better skin moisture retention. Research-based data demonstrate that this treatment shows promise for ongoing illness control, mainly within people who suffer from persistent lichenification conditions [3].

3-2- Mechanisms of Action

• Laser treatment for (AD) enables control of immune activity by focusing on specific inflammatory cytokines linked to the disease processes. Excimer lasers help to decrease the formation of interleukin-4 (IL-4) and tumor necrosis factor-alpha (TNF-α), which serve as essential components during (AD) development. The therapeutic impact of low-level laser therapy (LLLT) includes IgE level decline, which proves its potential to manage allergic reactions [6].

• Laser treatments decrease symptoms of (AD) by directly blocking harmful inflammatory molecules, which are present in the affected areas. The application of pulsed dye lasers helps reduce inflammation of blood vessels, which are central to erythema development in (AD) patients. The advantage of this property helps reduce skin burning sensations and decreases itching, thereby enhancing patient satisfaction rates [5].

• Through laser therapy treatments, patients experience substantial benefits to their skin barrier by improving processes of TEWL and skin hydration. The barrier function of skin becomes more robust through fractional CO2 lasers because they boost collagen production while stimulating keratinocyte multiplication [3].

3-3- Evidence from Clinical Trials and Case Studies

• The 308-nm excimer laser has demonstrated its effectiveness for treating patients with moderate-to-severe (AD) through a crucial research study. Treatment for eight weeks resulted in substantial improvements in both SCORAD (Scoring Atopic Dermatitis) scores and EASI (Eczema Area and Severity Index) scores according to research findings. The modality proved best at treating localized (AD) skin areas that could not be controlled with standard treatment methods [2].

• Research findings show that the Pulsed Dye Laser produces effective erythema and telangiectasia reduction in the faces of patients with (AD). The PDL treatment of three patients with (AD) proved effective at improving symptoms without causing either pigmentation loss or skin blisters [5].

• Fractional CO2 Laser showed promising results in studies about chronic (AD) because it improved epidermal thickness and symptom scores according to research. The study results demonstrated the strongest effectiveness in patients displaying lichenified plaques, which established fractional CO2 laser as a solution for difficult-to-treat (AD) subtypes [3].

• Laser therapy in combination with pharmaceutical agents known as topical corticosteroids outperforms individual clinical approaches according to comparative studies. Clinical tests combining intravenous laser blood irradiation with normal drug treatment showed patients attained better cytokine level reductions and lower relapse rates compared to drug treatments in isolation [6].

Drug Therapies

Traditional (AD) management depends on pharmaceutical treatments that both reduce symptoms along with treating inflammation, and enhance patient well-being. Three fundamental drug treatment approaches for (AD) include topical corticosteroids along with calcineurin inhibitors and the biologic therapy named dupilumab. The discussion includes examination of side effect risks together with treatment resistance and variations in patient reactions to these treatments.

4-1- Topical Corticosteroids (TCS)

The main therapeutic tool for treating (AD) is the topical corticosteroid, which demonstrates strong anti-inflammatory activity together with immunosuppressive properties. The drugs inhibit phospholipase A2 activity and control cytokines and pro-inflammatory mediator formation. The severity of (AD), along with the treatment zone, determines which concentrations of topical corticosteroids physicians should prescribe [7]. The face and intertriginous zones require the use of low-potency steroids, whereas stiffer or more significant lesions need mid- to high-potency steroids. Continued use of topical corticosteroids results in various adverse effects for patients across all ages, although they demonstrate efficient treatment of skin conditions. Patient treatment with corticosteroids often leads to the development of resistance that requires healthcare providers to find different treatment options [8].

4-2- Calcineurin Inhibitors

The effective steroid alternative treatment for sensitive skin areas at risk of steroid-induced atrophy consists of tacrolimus and pimecrolimus, which belong to the calcineurin inhibitor group. These medications work through two mechanisms to stop T-cell activation while blocking the inflammatory cytokines, including IL-2, IL-4, and IL-13. Scientific evidence shows that calcineurin inhibitors succeed when used to keep inflammation under control and lower recurrent flare-ups in patients with moderate-to-severe (AD) [9].

Since calcineurin inhibitors lack the side effect of skin atrophy, they become suitable options for long-term treatment of facial and neck regions. Doctors restrict the usage of calcineurin inhibitors because patients experience burning and stinging sensations right after medication application. The danger of developing malignancies remains an ongoing concern even though long-term research has not confirmed this possibility [10].

4-3- Biologics (e.g., Dupilumab)

The introduction of biologic therapeutic approaches brings a revolutionary change to treat moderate-to-severe (AD) when standard treatments prove ineffective. Studies demonstrate that Dupilumab demonstrates impressive outcomes in lowering disease intensity and itch because it blocks IL-4 and IL-13 receptor cytokines important to type 2 inflammation. The systematic clinical trials reveal that Dupilumab successfully improves both SCORAD and EASI scores and maintains its therapeutic effects during extended usage periods [1]. The safety profile of dupilumab treatment is positive because patients most often develop conjunctivitis as the main side effect. The high price of this treatment creates substantial challenges for patients from limited-resource areas wishing to obtain it. Treatment options with tralokinumab (IL-13 blocker) and nemolizumab (IL-31 blocker) show promise to combat (AD) related needs through different stages of clinical development [7].

4-4- Challenges in Drug Therapies

- Drugs used in the treatment of eczema present substantial difficulties because they produce unwanted effects among patients. The use of topical corticosteroids causes skin thinning along with substantial systemic absorption among severe patients, yet calcineurin inhibitors require medical attention due to local irritants and possible carcinogenic risks. The safer nature of biologic therapy remains crucial, yet patients should undergo risk evaluation because they can trigger dysregulation of the immune response and subsequent secondary infections [11].

• The development of drug resistance through prolonged use of topical and systemic treatment products requires periodic changes to treatment protocols due to tachyphylaxis effects. Temporary effectiveness failure of both corticosteroids and calcineurin inhibitors requires healthcare professionals to initiate supplemental treatment methods [12].

• The medical challenges associated with treating (AD) patients become more complex because of the diverse range of disease characteristics. Patient drug response depends on genetic variations, along with the severity of their condition, combined with their additional health issues. The effectiveness of dupilumab extends to most patients, yet some people show limited benefits or become resistant, which necessitates biomarkers for predictive evaluation of treatment effectiveness [13].

Comparative Analysis

The evaluation between laser treatments and pharmaceutical approaches for atopic dermatitis (AD) shows distinct outcomes regarding their effectiveness and safety aspects, as well as financial considerations. The latest evidence demonstrates key attributes and drawbacks of these modalities while showing their optimal clinical applications.

5-1- Efficacy and Application

Multiple laser techniques, such as excimer and pulsed dye, and fractional CO2 lasers, effectively treat individual symptoms of (AD). Applications of the excimer laser present dual benefits by decreasing inflammation while simultaneously improving skin barrier integrity through directed UVB phototherapy [2]. The treatment method achieves notable reductions of both SCORAD (Scoring Atopic Dermatitis) and EASI (Eczema Area and Severity Index) metrics, especially for (AD) patients with limited therapeutic options after topical treatment. The treatment of (AD) associated erythema and telangiectasia uses Pulsed dye lasers (PDL) as an effective option for vascular modulation [5]. The treatment of extensive (AD) becomes flexible through the implementation of topical corticosteroids and calcineurin inhibitors, and biologic medications like dupilumab.

The IL-4 and IL-13 pathway therapeutic strategy in dupilumab represents a breakthrough in (AD) management because it produces notable reductions in disease inflammation and itchiness [1]. Data from systematic studies confirms that systemic treatments provide superior management of moderate-to-severe (AD) compared to placebo, thus showing better results in extensive (AD) cases. Localized symptom relief stands as a primary strength of laser therapies because these treatments succeed when topical drug therapies prove ineffective [14]. Systematic pharmaceutical drugs deliver better outcomes for extensive conditions, while these therapeutic procedures cannot reach large infected areas. Research demonstrates better results emerge when patients combine treatment with excimer lasers and topical corticosteroids affecting this same condition [6].

5-2- Side Effects

• The utilization of laser therapies produces fewer widespread adverse reactions than pharmaceutical medications do. The most typical side effects from these therapies affect only the treated area and potentially cause limited skin irritation and redness, and color changes that disappear independently. Excimer lasers demonstrate rare instances of worsening skin sensitivity for some patients; therefore, healthcare providers must prioritize patient selection [3].

• The administration of drugs leads to a wider spectrum of adverse effects than other treatment approaches do. Repeated use of topical corticosteroids can cause three serious side effects, which are skin atrophy alongside telangiectasia, and the formation of striae. The systemic medication dupilumab could cause injection-site reactions together with conjunctivitis when used. The use of calcineurin inhibitors leads to burning sensations while potentially increasing cancer risk, although studies cannot verify these possible risks [10].

• The localized treatment of eczema through laser therapy avoids safety complications for patients who experience adverse reactions from medical drugs. Systemic therapies maintain their essential role in treating widespread disease even though they present their risks to patients.

Treatment choices need to balance risks against benefits, while medical professionals should select therapies specific to individual patient conditions, plus the level of their disease severity.

5-3- Cost and Accessibility

The financial cost of laser treatments depends on three factors: the treatment device and the number of required sessions, and the location where treatment occurs. Medical applications using Excimer and fractional CO2 lasers need numerous treatment sessions that result in elevated initial expenses. Lack of accessibility exists in resource-limited settings because these areas do not have access to specialized equipment or trained personnel [6]. Patients face major expense challenges when using drug therapies, but especially when using biologic medications such as dupilumab. The high price of dupilumab and the need for long-term administration pose financial challenges for patients and healthcare systems [12]. The generic version of corticosteroids also combines with calcineurin inhibitors to provide patients with more affordable treatment options for the initial stages of the condition. Initializer expenses of laser therapy systems are high, but specific cases benefit when the treatment focuses on targeted areas and produces extended periods without symptoms. Biologic medications give systemic relief to patients, but patients need to endure repeated expenses. Research shows that combining laser treatments with medication would deliver better results at potentially reduced expenses [15].

Outcomes Analysis: Comparative Efficacy, Safety, and Patient Adherence

Scientific studies show that localized treatment of atopic dermatitis (AD) succeeds best with laser therapy methods. Study results suggest that UVB phototherapy using excimer lasers has two main benefits: it enhances Eczema Area and Severity Index (EASI) scores, and it decreases the sensation of itching. The treatment of erythematous lesions through Pulsed dye lasers (PDL) works through vascular factor modulation [2]. Fractional CO2 lasers strengthen the skin barrier through collagen reconstruction while helping to heal the epidermis and reducing inflammation.

The therapeutic outcomes of these treatments remain confined to certain areas where lesions exist and do not adequately address extensive or acute medical situations. The introduction of drugs, particularly biologic dupilumab, has fundamentally changed (AD) therapy because it effectively decreases inflammatory symptoms and itching [15]. Patients taking dupilumab experience both EASI-75 and EASI-90 responses consistently because this treatment blocks IL-4 and IL-13 signaling pathways in patients with moderate-to-severe (AD). Systemic agents, including upadacitinib and baricitinib as Janus kinase inhibitors, have proven their ability in achieving EASI-75 outcomes along with reduced itch both during short-term and extended follow-ups [14]. The benefits of drug therapies steadily decline after treating patients who show resistance to regular (AD) treatment during long-term care. The safety features of laser therapies result in most adverse effects being localized yet short-term in nature. Anti (AD) medications produce three main secondary effects, which consist of skin redness followed by transient skin discomfort and oxidative pigment changes [5]. Specific types of skin show extremely rare reactions to excessive UVB rays, including skin sensitivity aggravation or burns. The application of lasers maintains safety standards within supervised medical facilities. Drug therapies create more diverse possibilities for adverse effects to develop. Prolonged application of topical corticosteroids results in skin thinning as well as the appearance of striae and telangiectasia. The use of Calcineurin inhibitors brings burning sensitivities to the skin, while researchers now show they cause little to no cancer emergence. People using dupilumab with JAK inhibitors might develop conjunctivitis alongside upper respiratory tract infections, but they rarely experience reactions at their injection sites [1]. Their long-term therapeutic use remains safe even though potential adverse effects exist. The usage of laser therapy as a treatment depends largely on cost elements and ease of access, together with convenience factors. Regular sessions at specialized centers present an inconvenient option for patients because they must navigate to these facilities frequently, including people living in underserved regions.

Treatment fatigue becomes more likely because patients usually need to schedule multiple sessions to keep experiencing the desired effects [6]. Patients tend to stay with their treatment plan because they do not experience any harmful side effects affecting their entire body, which specifically helps with localized (AD) management. Patients tend to follow drug treatments, including the biologic agent dupilumab, because of its systemic therapeutic properties, along with limited administration frequencies, which include biweekly injections. The treatment cost and possible side effects, such as conjunctivitis and immune dysregulation, work as barriers to sustaining long-term patient adherence. Topical corticosteroids together with calcineurin inhibitors need daily use, yet people are likely to struggle with following their treatment because of difficult regimens and possible adverse effects [10].

Clinical Significance: Impact on Treatment Protocols

(AD) care requires a new evaluation of established management practices to accept innovative treatments that enhance patient success. New research demonstrates that laser treatments and medications complement each other in the management of (AD) while demonstrating the value of patient-centered treatments driven by evidence. The section explains how new research data will transform present treatment standards with improved clinical effectiveness. Evidence indicates the use of lasers for treating localized (AD) skin problems, while drugs serve best for managing the entire system [2]. Laser treatment programs, which incorporate excimer and pulsed dye laser systems, have proven successful at decreasing skin redness and strengthening the skin barrier while reducing inflammatory processes of specific areas on the skin. Dupilumab and other systemic biologics are vital components when treating (AD) spread across large areas or cases that resist treatment [15]. By dividing (AD) treatment into stages according to severity, clinicians enhance therapeutic effectiveness while avoiding unnecessary drug exposure to the entire body.

The current evidence suggests fostering beneficial interactions between laser and drug therapy for disease treatment effectiveness. Scientific investigations that bring together excimer laser therapy with topical corticosteroids demonstrate both accelerated symptom relief and longer-lasting remission periods [7]. Healthcare providers may establish combination therapy protocols as routine practice for treating moderate patients who respond partially to single medications. Patients who have mild-to-moderate (AD) can benefit from laser treatments since they represent a secure method that leads to only minimal skin irritation and transient color changes at the treatment site. Medical practices require patients at systemic drug reaction risk and those limited to pharmaceutical options to receive top priority for these treatment methods [5]. Patients who use dupilumab or receive JAK inhibitor treatment such as upadacitinib must undergo pre-treatment counseling and monitoring due to systemic therapy adverse events, including conjunctivitis and acne. Future clinical practices should incorporate secondary treatments aimed at reducing adverse effects to boost patient treatment adherence [14]. Patient adherence to biologics such as dupilumab becomes higher as these medications have both less frequent administration requirements and strong therapeutic effects across the body. These treatments face barriers because they are expensive to access [15]. The added utilization of generic topical treatments along with intermittent laser therapy sessions for mild cases shortens patient expenses [11]. Through patient evaluations conducted using telemedicine platforms, there is improved medication compliance in extended treatments where biologics need continuous delivery. The initial investment in laser therapies leads to long-term financial benefits since they provide better value than sustained systemic therapy for controlling persistent localized (AD) [6]. Research shows that the original expenditure justifies itself through limited treatment appointments combined with extended periods of symptom control. Healthcare systems together with patients face a substantial financial burden because dupilumab and JAK inhibitors need ongoing administration [1].

The new protocols should fight for broad insurance coverage combined with reimbursement benefits for new medical treatments. The selection of reimbursement policies with lasting cost benefits should be guided by evidence-based analyses that contain laser and drug therapy comparison results according to policymakers. Treatment protocols must be personalized because (AD) shows diverse characteristics among patients, thus requiring consideration of factors including genetic makeup and environmental and immunological elements [14]. The current literature provides evidence that demonstrates the necessity to find biomarkers for therapy response prediction to achieve precise laser or medication intervention selection. Available studies show that combination therapy works well, but researchers lack enough data about its long-term safety profile, along with price and patient welfare outcomes [10]. Healthcare research groups should conduct clinical trials to develop optimal treatment protocols by integrating laser therapies with biologics or JAK inhibitors. The combination of laser and drug-based strategies shows great potential to improve current (AD) management protocols. Research findings about disease severity and patient adherence, together with safety measures and economic solutions, create a strategic path to establish sustainable (AD) management practices [6]. Moving these research findings to clinical standard practice demands future investigation and strategic policy changes in order to achieve the best results for numerous patient demographics.

Research Gaps and Future Directions

Medical research into atopic dermatitis (AD) treatment continues to progress, yet scientists need improved approaches to maximize the potential of laser and drug therapy delivery. Future efforts should focus on specific research initiatives to maximize both safety and effectiveness alongside accessibility of available (AD) care options. Future research needs to focus on developing combined laser-guided pharmaceutical approaches, as this section defines essential priorities for upcoming examinations.

1. Optimizing Combination Therapies

Available data demonstrate that laser therapy and drug therapy applications work jointly through distinct mechanisms of action. The combined utilization of lasers with pharmaceutical agents benefits patients through their anti-inflammatory effects, which strengthen skin barriers as pharmaceuticals manage whole-body immune abnormalities. Such combined therapeutic approaches would most effectively help patients with moderate-to-severe (AD). The scientific community lacks comprehensive information about the proper ordering of treatments and appropriate doses, and specific times of combined therapy applications.

Future Studies:

- A study should compare the effectiveness of treating patients with the combination of excimer laser and dupilumab treatment versus administering either agent individually in moderate-to-severe (AD) cases.
- Data collection seeks to determine how pulsed dye laser (PDL) works with topical calcineurin inhibitors to manage facial (AD) symptoms.
- Research studies should follow patient participants over time to measure the sustained remission outcomes along with quality of life improvements from mixed therapies.

2. Personalized Treatment Protocols

(AD) shows such differences among patients that demand unique treatment plans for each individual. Some key elements that determine how treatments affect (AD) patients include their genetic risks combined with their immune system functions and the extent of their illness. The current medical approaches fail to achieve precise therapy selection for specific patients, particularly when combining lasers with drugs for treatment.

Future Studies:

- Researchers need to find biomarkers that indicate which patients will respond well to laser therapy treatment through assessing skin barrier indicators or cytokine levels.
- Genomic research will explore groups of patients who would benefit from combining laser therapy with biologic medications.

• The combination of artificial intelligence models processes clinical and genetic information to refine tailored treatment choices for each patient.

3. Long-Term Safety and Efficacy

Laser treatment methods generally present no significant danger, but researchers lack extended evidence demonstrating their safety when combined with systemic medication applications. The complete effects that duplicate biologics have on the immune system will require more detailed research in the future.

Future Studies:

• Five through ten years of research should analyze the Safety and success rates of laser combination therapies with biologic interventions.

• The study must evaluate the combined skin health impact that occurs from multiple laser treatments over time.

• Examinations should explore immunological changes that occur when biologic medications are used over long periods while patients receive photobiological medical treatments.

4. Pediatric and Geriatric Populations

Patients of both childhood and elderly age groups demonstrate individualized disease patterns together with different treatment outcomes. Major deficiencies in research data exist for these vulnerable population groups because most studies have primarily worked with adult participants.

Future Studies:

• Safety and efficacy trials of excimer lasers in pediatric (AD) patients, particularly in combination with low-potency topical steroids.

• Researchers need to conduct clinical studies about implementing fractional CO2 laser therapy for elderly persons suffering from chronic lichenified (AD).

• Research should examine the effectiveness and treatment adherence rates through combination treatment approaches among these specific patient groups.

5. Cost-Effectiveness and Accessibility

High investment in biologics, together with laser treatments, hinders their adoption by wider healthcare facilities. The research community requires immediate examination of cost-efficient methods for making treatment more accessible throughout low-resource communities.

Future Studies:

• Researchers should conduct cost-benefit assessments that compare single-drug therapies with drugs and lasers, along with combined pill-laser product usage.

• Evidence-based studies need to assess low-resource area laser therapy programs that receive government subsidies.

• The development of affordable handheld laser technology should be pursued for both clinic and home settings.

6. Mechanistic Insights

The specific tissue effects produced by laser treatments, which modify immunity while improving skin defense capabilities, are not fully understood by scientists. The research needs additional investigation to understand how laser therapy alters the skin while interacting with drug compounds.

Future Studies:

• Scientists need to analyze the molecular signaling patterns that occur in skin affected by (AD) after laser treatment.

• Research should evaluate how laser exposure affects both the absorption patterns and movement behavior of topical skin medicines and system-wide pharmaceutical formulations.

• Research teams should perform preclinical studies to assess immunomodulator-agent combinations with laser therapy.

7. Patient-Reported Outcomes

Clinical scoring systems such as SCORAD or EASI remain essential for evaluating dermatitis, but patient-reported outcome measurements provide critical insights about real-life treatment effects. Research today fails to address the psychological and social effects of treating (AD).

Table 1 . Comparative Clinical Outcomes

Therapy	Time to Symptom Relief	Patient Satisfaction	Remission Duration	Efficacy (EASI-75 Achievement)
1. Laser Therapy	Faster for localized lesions	High	Moderate	High for localized lesions
2. Drug Therapy	Slower but systemic	Moderate to High	Longer with biologics	High for systemic involvement

Figure 2 . Mechanisms of Action: Laser vs. Drug Therapies

Table 2 . Side Effects Analysis

Side Effect	Laser Therapy	Drug Therapy
1. Localized Irritation	Common	Not applicable
2. Pigmentary Changes	Rare	Not applicable
3. Systemic Side Effects (e.g., Conjunctivitis)	Not applicable	Common with biologics
4. Skin Thinning	Not applicable	Common with corticosteroids

Table 3 . Cost-Effectiveness Analysis

Therapy	Initial Cost	Long-Term Cost	Accessibility
1. Laser Therapy	High (multiple sessions)	Potentially lower (localized cases)	Limited in low-resource settings
2. Drug Therapy	Moderate to High (depending on drug)	High (systemic, long-term use)	Variable (depends on insurance coverage)

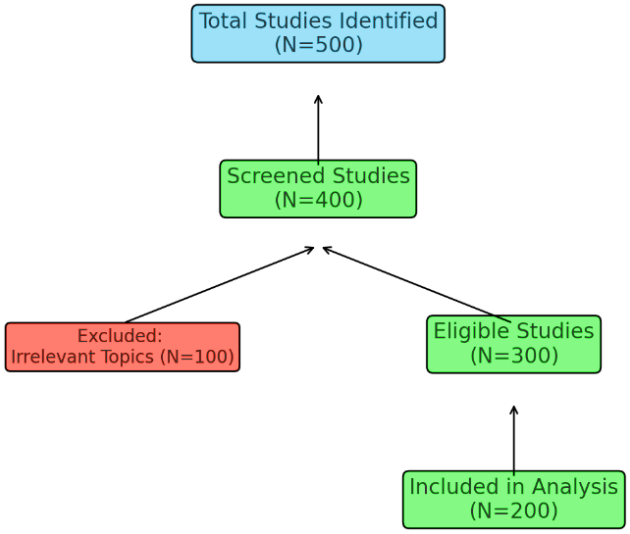

Figure 1 . Flowchart of Included Studies

Conclusion

Advanced medical techniques in atopic dermatitis treatment continue to develop because laser and medication therapies support each other for symptom management, along with disease control. The three types of laser therapy devices, namely excimer along with pulsed dye, and fractional CO2 lasers, utilize their power to treat specific (AD) areas and both control infections together with decrease inflammation while tightening the skin's protective layer. These therapeutic modalities provide safe treatment that causes few general systemic adverse effects, so they appeal to patients with both localized atopic dermatitis as well as treatment-resistant lesions. Drug treatments stand as the primary treatment approach for the management of systemic (AD). Dupilumab and similar biologics revolutionize reversible (AD) management by focusing on immunity pathways that cause this condition. Medical treatments support patients who have extensive or severe (AD) manifestations by offering effective relief from itch and minimizing lesion severity, and enhancing their overall quality of life. Systemic side effects, together with large financial costs, work against the universal use of these treatments, especially in resource-constrained areas. The evaluation of these therapeutic approaches demonstrates their separate functions in (AD) management. For two specific groups of patients, laser therapies provide effective care because these patients do not benefit from topical applications and also cannot use systemic medications. The treatment of systemic inflammation and serious disease requires drug medications to be effective. Synthesizing these treatment methods can produce superior outcomes through targeted laser effects paired with the systemic benefits of pharmaceutical agents, including biologics.

Through a combined treatment strategy, doctors may achieve stronger disease control and speed up symptom recovery while extending disease remission. The clinical progress in this sector encounters continued obstacles because patients exhibit inconsistent outcomes, while necessary treatment specifications must be individualized, and advanced treatment costs remain a significant issue. Additional studies need to enhance combination therapy protocols and create patient-specific biomarkers to guide treatment choices and measure long-term risks and expenses of these treatment approaches. Laser and drug therapies function as essential components for managing (AD) since they address different SDUs in the disease pathway. When clinicians integrate differing treatment approaches into custom treatment designs for individual patients, they will obtain improved long-term healthcare benefits for (AD) patients. The complete potential of these therapies needs further research innovations, which should focus on meeting the therapeutic needs of patients from different population groups.

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The author declare no conflict of interest.

Authors' contributions

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