Laser and Light-Based Therapies for Hirsutism Management in Women With Polycystic Ovarian Syndrome: A Systematic Review

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Key Points

Question: Are laser and light-based hair reduction therapies, either as standalone or in combination with other systemic therapies, effective in addressing hirsutism in adults and adolescents with polycystic ovary syndrome (PCOS)?

Findings: In this systematic review of 6 studies reporting data on 423 patients, laser and light-based therapies were found to be effective in reducing hirsutism severity, improving psychological well-being and enhancing quality of life in women with PCOS, with generally tolerable side effects. Simultaneous use of metformin or the combined oral contraceptive pill may offer additional benefits.

Meaning: These findings alongside broader efficacy data and patient preference, informed the 2023 International Evidence-based PCOS Guideline which has now introduced new recommendations on the use of laser and light-based hair reduction therapies for women with PCOS and hirsutism.

Abstract

Importance: Hirsutism represents a significant concern for women with polycystic ovary syndrome (PCOS) with deleterious psychological impacts, warranting acknowledgement and a clear imperative to provide effective management. To our knowledge, this is the first review to exclusively examine the effectiveness of laser and light-based therapies in addressing hirsutism in women with PCOS.

Objective: We aimed to synthesise the existing literature regarding the effectiveness of laser and light hair reduction therapies, either as standalone treatments or in combination with systemic agents, in treating hirsutism for women with PCOS.

Evidence Review: A systematic literature review was performed using MEDLINE, EMBASE, EMCARE and CINAHL according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines. Articles written in English, reporting on patients who met pre-established inclusion criteria were selected. Objective and subjectively measured outcomes relating to the effect of laser or light-based hair reduction therapies on hirsutism were abstracted. Heterogeneity among included studies precluded a meta-analysis, necessitating a narrative synthesis.

Findings: 6 studies reporting data on 423 individual patients with PCOS who underwent laser or light-based hair reduction therapies were included: 4 randomised control trials and 2 cohort studies. Alexandrite laser demonstrated significant improvements in hirsutism severity and psychological outcomes, particularly at high-fluence application. Alexandrite laser was also found to be more effective than intense pulsed light (IPL). The combination of diode laser with either metformin or combined oral contraceptive pill was superior to the application of diode laser alone, just as the addition of metformin to IPL demonstrated superior results to IPL treatment alone. Overall, most interventions were well tolerated. The overall certainty of evidence across all outcomes and comparisons was limited in part due to the observational nature of some studies.

Conclusions and Relevance: This systematic review highlights the potential of laser and light hair reduction therapies, both as standalone treatments and in combination with other pharmacological agents in PCOS. The results from this review contributed to informing the 2023 International Evidence-Based PCOS Guideline which has now introduced new recommendations on the use of laser and light-based hair reduction therapies for women with PCOS and hirsutism.

1. Introduction

Hirsutism, the excessive growth of terminal hair in a male pattern in women, is characterised by coarse and pigmented hair growth in androgen-dependent areas such as the face, chest, abdomen and back.[1,2] Driven by excess androgen production or increased androgen-sensitivity at the hair follicles, polycystic ovary syndrome (PCOS) stands out as the predominant underlying factor.[1,3] While hirsutism affects approximately 10% of the general population, its prevalence rises significantly to 70-80% among women with PCOS.[1,3]

PCOS is a complex endocrinopathy characterised by hyperandrogenism, ovulatory dysfunction and polycystic ovary morphology.[4,5] It is the most common endocrinopathy in women and has detrimental reproductive, cardiometabolic and psychological health implications.[5] Hirsutism, despite being a prominent clinical feature of PCOS, is often downplayed as a cosmetic issue by healthcare professionals. However, hirsutism exerts profound psychological impacts on affected women including impaired self-esteem, reduced quality of life (QoL) and increased depression.[6-8] The burden is further worsened by the substantial time and energy invested in removing unwanted hairgrowth.[9]

Traditionally, hirsutism management revolves around temporary hair removal techniques such as waxing, shaving, and epilating.[10] Oral pharmacological therapies such as combined oral contraceptive pills and antiandrogens whilst offering some efficacy, are often inadequate and may be contraindicated or have adverse effects.[11] Although laser and light-based hair reduction therapies have gained popularity for longer-term management of hirsutism with minimal systemic adverse effects,[12,13] research specific to women with PCOS is scarce, leaving a significant gap in knowledge.

In line with growing recognition of the impact of hirsutism in PCOS management, the 2023 International Evidence-Based PCOS Guideline has prioritised the management of hirsutism in PCOS.[14] Therefore, the aim of this systematic review is to synthesise the existing literature regarding the effectiveness of laser and light hair reduction therapies, either as standalone treatments or in combination with systemic agents, in addressing hirsutism in women with PCOS.[15]

2. Materials and Methods

This systematic review adheres to recommendations of the Preferred Reporting Items of Systematic Reviews and Meta-analyses (PRISMA).[16] It was designed *apriori* and protocol is available online in the PCOS guideline technical report.[17] Electronic databases including MEDLINE, EMBASE, EMCARE and CINAHL were searched in duplication (KT, TC) from inception until the 4th of August 2022. The search strategy included key words such as PCOS, hirsutism, hypertrichosis, photo-epilation, laser, electrolysis etc., with no date restrictions (see Appendix 1).

Eligibility of studies was assessed using the Population-Intervention-Comparator-Outcome-Study (PICOS) criteria. In summary, all comparative studies (randomised controlled trials (RCTs) or observational studies) examining laser and light-based hair reduction therapies alone or in combination with other treatments in women with PCOS were included. Outcomes of interest included any type of measurement for hirsutism severity, psychological outcome, cost, and side-effects. Non-English publications, case series, case reports, narrative reviews, and publication in abstract form or conference proceedings were excluded.

Title and abstract, followed by full text assessment were screened in duplication (KT, TC). Conflicts were resolved through discussion, with arbitration by a third reviewer where necessary. Data extraction included study design, publication year, country, population, sample sizes, interventions, comparisons, follow-up duration, outcome measures, and narrative summaries of the main findings. Due to considerable heterogeneity among the included studies, a narrative synthesis was completed.

Risk of bias was assessed independently by KT and TC using a tool adapted from the revised Cochrane risk of bias assessment tool and the ROBINS-I tools, as appropriate to the study design.[18] Quality of the evidence was appraised by two independent reviewers (KT, AM) using the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) tool displayed in Tables 1, 2 and 3.[19]

3. Results

3.1. Search results and study characteristics

Figure 1 depicts the PRISMA flow diagram. A total of 210 articles were identified from the literature search. After removal of duplicates and screening of titles and abstracts, 22 full-text articles were reviewed. Six studies totalling 423 participants met the inclusion criteria, consisting of four RCTs[20-23] and two cohort studies.[24,25] Excluded studies are outlined in Appendix 2.

Table 4 presents the study characteristics. The therapies investigated were alexandrite laser,[20,22,24] diode laser,[21,25] and intense pulsed light (IPL) therapy.[22,23] All studies examined facial hirsutism. The sample sizes ranged from 31-150 participants. All but one study[22] included adult women only. PCOS diagnosis was determined using the Rotterdam Criteria in three studies,[21,23,25] the remaining relied on diagnoses by referring specialists.[20,22,24] Included participants had varying Fitzpatrick skin phototypes (FST) I-V, half of the studies specified inclusion of participants with dark hair[20,22,24] and the others did not specify.[21,23,25] Diagnostic criteria for hirsutism were not specified in four studies.[20,22,24,25] The remaining two studies used the Ferriman-Gallwey score (FG),[21,23] but only one specified a cut off score >8.[23]

Assessment of hirsutism severity included self-reported severity, clinician-assessed hair counts, time spent to remove unwanted hair, hair free intervals (HFI) and trichoscopic features including hair width/thickness. Psychological outcomes assessed included self-reported patient satisfaction, impact on QoL using the Dermatology Life Quality Index (DLQI),[26] the World Health Organisation's 'Measuring quality of life' tool,[27] Hospital Anxiety and Depression Scale (HADS),[28] Rosenberg Self-Esteem Scale,[29] as well as the Hirsutism Life Quality Index (HLQI) specifically designed by Dorgham et al.'s study.[21] Follow-up periods ranged from no follow-up[25] to 6 months post-treatment cessation.[20-22,24]

3.2. Risk of bias and GRADE assessment

Risk of bias assessments are summarised in Supplement Tables 3a & 3b. Three studies[30-32] were rated as high risk of bias, and three[33-35] were rated as moderate risk of bias. Certainty of the evidence across all outcomes was rated as low or very low due to the observational nature of some studies, risk of bias of included studies as well as imprecision caused by small sample sizes or single studies per outcome.

3.3. Evidence Synthesis of the effectiveness of hair reduction treatments

3.3.1. Alexandrite laser

Alexandrite laser alone

McGill et al.'s cohort study of 60 women with PCOS[35] reported a reduction in mean hair counts from first treatment to 6 weeks after the sixth treatment (mean ± Standard Deviation (SD) = 31 ± 38.0%, p=0.001). HFI significantly lengthened with treatment: mean of 1.9 weeks after six treatments, to 4.3 weeks after ten treatments (p=0.001) with high levels of patient satisfaction. Adverse effects (AEs) were included on the follow-up postal questionnaire; however, results were not reported.

Alexandrite laser: high fluence vs. low fluence

Clayton et al.[33] compared high vs. low fluence alexandrite laser in a group of 88 women with PCOS. The high fluence laser group exhibited a statistically significant improvement in self-reported severity of facial hirsutism [ANCOVA $F_{(1,83)} = 24.5$, $p<0.05$], time spent on hair removal [(112 mins to 21 mins weekly vs. 92mins to 56mins weekly (ANCOVA $F_{(1,80)} = 10.2$, $p\leq 0.05$)] and longer duration of HFI [24.4 ± 18.5 days vs. 5.9 ± 9.1 days (ANCOVA $F_{(1,79)} = 28.6$, $p< 0.01$)] compared to the low fluence laser treatment group. Furthermore, the high fluence treatment compared to low fluence treatment had improved psychological outcomes including mean score for HADS depression (6.7 to 3.6 vs. 6.1 to 5.4; ANCOVA $F_{(1,83)} = 14.7$,$p\leq 0.05$), HADS anxiety (11.1 to 8.2 vs. 9.1 to 9.3, ANCOVA $F_{(1,80)} = 17.8$, $p\leq 0.05$), and WHO QoL psychological domain (rising from 49.6 to 61.2 vs. 50.1 to 51.5; (ANCOVA $F_{(1,84)} = 10.9$, $p< 0.05$). No significant difference was observed in the Rosenberg Self-Esteem Scale at 6 months of follow-up. AEs were not reported.

Alexandrite laser vs. IPL

In their split-faced RCT (n=38), McGill et al.[34] administered the Lumina IPL system, incorporating a 650-1100nm filter applied with a 3cmx1cm quartz block. Patients with FST I-III received starting fluencies of 26-28 J/cm^2 increasing up to 42J/cm^2 as tolerated. Three pulses of 55ms duration were applied with 20ms delay between pulses. Patients with FST IV were started at 16-18 J/cm^2 increasing to 24-28 J/cm^2 delivered as four pulses of 140ms duration, with 40ms delay. Researchers reported alexandrite laser being superior to IPL for

significantly longer self-reported HFI after all six treatments ($p<0.005$) and greater decrease in hair counts at the 1-, 3- and 6-month follow-up points (46% vs. 27% at the end of the study, $p<0.001$). Patient satisfaction was significantly higher for the alexandrite-laser treated side compared to the IPL-treated side across all follow-up stages ($p\leq0.002$). 13% of participants experienced purpura from higher fluences of the alexandrite laser; whereas on the IPL-treated side, 10% of participants developed blistering and a further 6% developed notable areas of leukotrichia.

3.3.2. Intense Pulsed Light Therapy

IPL was used in two RCTs. McGill et al.'s split-face RCT[34] reported that alexandrite laser was more effective than IPL (see section 3.3.1.). Rezvanian et al.[30] investigated the efficacy of IPL alone and in combination with metformin in 52 women with PCOS. The Ellipse Relax Light 1000 IPL system with a 600-nm filter was used, guided by a 48x10mm light-conducting crystal. Pulses of 5-40ms duration were applied with fluencies of 17-21.7 J/cm^2 selected according to FST and review of immediate reaction to IPL. Quantity of pulses and delay between pulses was not specified. At 6-month follow-up post the final IPL session, women in the combined IPL/metformin group experienced significantly greater improvements in their overall FG score (-2.04 vs. -1.01, p=0.002), self-reported hirsutism using a visual analogue sliding scale (VAS) (ranging 0-100%) (52.9 $\pm$ 26.3% vs. 34.1 $\pm$ 28.1%, p=0.019) and hair count reduction (22.14 $\pm$ 10.52cm^2 vs. 29.7 $\pm$ 14.67cm^2, p=0.044) than those receiving IPL alone. No significant difference was noted in hair thickness reduction (p=0.30). No psychological outcomes were measured in this study. AEs were reported in twelve participants who received IPL/metformin, including transient nausea, diarrhoea and abdominal pain/discomfort which were attributed to metformin. 1 participant ceased metformin due to intolerance of side effects.

3.3.3. Diode Laser

Diode laser alone and in combination with systemic agents

In their three-group RCT, Dorgham et al.[12] compared the efficacy of a diode laser on its own (n=50), and in combination with either 500mg metformin (n=50) or a combined oral contraceptive pill (COCP, Diane-35®)(n=50) on hirsutism and related QoL measures. While all

three study groups reported improvements in physician-assessed VAS scores after initial treatment and at 3- and 6-month follow-up sessions, the formal statistical analysis results and inter-group comparisons were not presented. Combined diode laser/COCP group experienced significantly greater improvements in mean DLQI scores and HLQI scores at 6 months (DLQI 1.0 ± 0.6; HLQI 1.45 ± 0.5) than diode laser/metformin (DLQI 5.1 ± 1.5, p=0.001; HLQI 4.48 ± 1.2, p=0.001) and diode laser only group (DLQI 5.5 ± 2.5, p=0.001; HLQI 6.5 ± 2.3, p=0.001). No significant differences were noted between participants who received diode laser only compared to combination of diode laser/metformin. Side effects from treatment were not reported.

LightSheer laser vs. Soprano XL

Pai et al.[32] compared the efficacy of two diode lasers [Soprano XL (Alma lasers Ltd, Caesarea Israel) in super hair removal mode vs. the LightSheer™(Lumenis, Inc., Santa Clara CA, USA)] in 42 women with PCOS. In this split face cohort study, the Soprano XL was administered as a low-fluence, high-repetition laser, whereas the LightSheer was administered as a high-fluence, low-repetition laser. After 6 treatment sessions, there was no significant difference in the overall median hair reduction between the two lasers (Soprano XL: 90.5%, SD=7 vs. LightSheer: 85%, SD=8.5%, p<0.063). However, Soprano XL was superior to LightSheer for median hair width reduction (0.02mm vs. 0.05mm, p<0.0005) and self-reported pain scores on a VAS (0 = no pain, 10 = unbearable)(median pain score: 2 vs. 6, p<0.0005). No participants reported any side effects from treatment.

4. Discussion

This is the first systematic review to assess the efficacy of laser and light-based hair reduction therapies for the management of hirsutism in women with PCOS. Overall, these therapies, both alone and in combination with systemic therapies, were effective in reducing hirsutism severity, improving psychological well-being, and enhancing QoL in women with PCOS, with generally tolerable AEs. Combining COCPs or metformin with laser treatment may offer additional benefits. However, the certainty of the evidence was rated as low or very low.

The treatment of hirsutism generally involves a combination of nonpharmacological, pharmacological, and noninvasive procedural interventions.5 Nonpharmacological options include shaving, threading, waxing, and plucking, among other things. Although simple and affordable, these are temporary measures that require frequent maintenance and AEs are common.10,33 Nonpharmacological therapies do not address the underlying hormonal imbalance responsible for hirsutism and are considered less effective for long-term hirsutism management. In contrast, pharmacological interventions are directed toward addressing the underlying hyperandrogenism of hirsutism.1

COCPs are the first-line pharmacological treatment recommended by the 2023 International Evidence-based PCOS Guideline for hirsutism.18 Containing synthetic estrogen and progestin combinations, COCPs reduce hyperandrogenism via suppression of gonadotropins secretion, inhibition of ovarian androgen production, and increased sex hormone-binding globulin to reduce androgen bioavailability.34 COCPs also provide benefits in menstrual cycle regulation, contraception, and endometrial protection in PCOS.35,36 Although generally safe, consideration of contraindications such as thrombotic risk, cardiovascular disease, and a history of migraines with aura is needed.37

The PCOS guideline recommends antiandrogens, such as spironolactone and finasteride, as second-line treatment in cases where response to COCPs is suboptimal or contraindicated.17 Antiandrogens block androgen receptors, decreasing androgen production and inhibiting 5-α reductase to reduce testosterone to dihydrotestosterone conversion.17,38Administering antiandrogens demands careful consideration in women due to their potential teratogenicity risk.39 Comprehensive patient counseling is vital, and adoption of reliable contraception practices is essential for sexually active women.18

Laser and light therapies are promising noninvasive procedural therapies for reducing hirsutism. With the appealing ability to provide long-lasting results,40 these treatments work by selective photothermolysis, whereby a specific wavelength of light targets melanin concentrated in hair follicles, leading to their destruction.41 Patients with darker skin are however more likely to experience AEs due to the concentration of melanin both in the hair follicle and the epidermis, which can cause thermal damage to adjacent tissues.42 Common AEs include skin burns, blistering, hyperpigmentation or hypopigmentation, purpura, and in

some cases, leukotrichia or paradoxical hypertrichosis.43 Despite the acknowledged increased AEs for people with darker skin, the systematic review by Manjaly and colleagues44 of 461 RCTs (n = 14 763) highlighted the underrepresentation of darker-skin phototypes (FSTs 5-6) in laser and light treatments research. Regrettably, this underrepresentation persists in our review where no studies included women with FST 5 to 6. This is concerning especially in the context of PCOS, where the prevalence of hirsutism and increased severity are observed more often in people with darker skin.45 Although not addressed by this review, strategies exist to mitigate AEs for individuals with darker skin. Ruby laser is typically avoided due to its excessive absorption by melanin, increasing risks of AEs.12,46 The longer wavelength neodymium-doped yttrium aluminium garnet (Nd:YAG) laser is generally safest for FSTs 4 to 6, although alexandrite and diode lasers are also effective.47 Using longer wavelengths, longer pulse durations,46and conservative fluence levels can minimize epidermal damage while effectively targeting hair follicles in darker skintypes.46,48 Pretreatment test spots,49 precooling, and parallel cooling50 may also enhance safety. Ensuring that practitioners are well trained in handling diverse skin tones and recognizing signs of AEs is pivotal. Future research should prioritize exploring optimal settings for laser and light therapies across varying skin tones.

Laser and light-based hair reduction therapies are used extensively in the general population for hair reduction and several systematic reviews have consistently demonstrated their efficacy.40,51 To our knowledge, this review is the first to focus on women with PCOS. Our results show that alexandrite laser demonstrated significant improvements in hirsutism severity and psychological outcomes,23,25,27 with high-fluence laser treatment showing superior results compared with low-fluence treatment.23 In addition, alexandrite laser was found to be more effective than IPL in reducing hair counts and prolonging hair-free intervals.25 The combination of diode laser with systemic agents (metformin or COCP) showed promising outcomes in terms of improved psychological outcomes.24 Similarly, the combination of IPL and metformin was superior to IPL alone in reducing hair counts and thickness.26 The comparison between 2 diode lasers revealed no significant overall difference in hair reduction, but there were some differences in hair width and greater patient tolerance.28 Informed by these findings, broader population-level data, patient preference, and expert input, the 2023 International Evidence-based PCOS Guideline has now introduced

new recommendations on the use of laser and light-based hair reduction therapies for women with PCOS and hirsutism. This is an advance from the previous version of the guideline and provides clinicians and women with PCOS evidence-based therapeutic options for hirsutism management.

As previously mentioned, Nd:YAG laser is the preferred laser for darker skin types because the longer wavelength (1064 nm) selectively penetrates the deeper levels of the dermis, thereby reducing the risk of superficial thermal damage.48,52 Two studies53,54 examining Nd:YAG laser treatment in women with and without PCOS were excluded from our review due to not meeting the predefined inclusion criteria. Nonetheless, their results offer valuable insights. Karn et al53 revealed that women without PCOS required fewer mean (SD) laser sessions (5.7 [1.01]) to achieve more than 50% reduction in hair count compared with women with PCOS (8.1 [1.28] sessions). Nabi et al54 observed more favorable outcomes in women with IH, showing greater reductions in various trichoscopic parameters, including hair shaft thickness, color, and hair density per cm2, compared with those with PCOS-related hirsutism. These findings suggest that women with PCOS may necessitate greater numbers of laser treatment sessions to achieve hair reduction compared with their counterparts without PCOS, with more research needed.

Strengths and Limitations

This systematic review presents several strengths. To our knowledge, this review is the first to focus on the effectiveness of laser and light-based hair reduction therapies for the management of hirsutism in women with PCOS. We used rigorous eligibility criteria based on input from global experts and consumers involved in the PCOS Guideline. In addition, we used the GRADE tool to evaluate the quality of evidence. However, this study has some limitations. The certainty of evidence across all outcomes was rated as low or very low due to the observational nature of some studies, small sample sizes, and single studies per outcome. In addition, the heterogeneity among the included studies precluded a meta-analysis. Most of the studies lacked specific diagnostic criteria for hirsutism.23,25,27 The follow-up periods may also not have been long enough to capture the effects of hair reduction treatments. Another important limitation is the underrepresentation of individuals with darker skin types

(FST 5-6), and the general paucity of information surrounding participant FST and/or race and ethnicity, rendering the generalizability of this review difficult for people of darker FST. The lack of included studies examining Nd:YAG laser is also unfortunate because it was the preferred laser for darker skin types.55 However the results from the 2 Nd:YAG studies mentioned earlier53,54 still support the use of Nd:YAG in women with PCOS. Finally, none of the included studies explored the potential benefits of combining antiandrogens with laser or light therapy for hirsutism. This leaves a gap in the current understanding of optimal treatment approaches for hirsutism in this population.

5. Conclusion

Hirsutism represents a major concern for women with PCOS. This systematic review highlights the potential efficacy of laser and light hair reduction therapies, both as stand-alone treatments and in combination with other pharmacological agents in those with PCOS and hirsutism. These interventions have demonstrated encouraging results in reducing hirsutism severity, enhancing psychological well-being, and improving overall QoL for affected individuals. However, this review is limited by low certainty of the evidence, few studies evaluating effectiveness and safety in those with skin of color, and heterogeneity in outcome assessment. These important gaps highlight the need for additional high-quality trials of laser and light therapies for management of hirsutism among women with PCOS that include diverse participants with a range of skin tones.

Author contributions

This systematic review is part of the ongoing 2023 update of the International Evidence-based PCOS Guideline, led by HT. Senior experts within the guideline working group included TP, CTT, AM, JB, HT, DR and AJ. AM and CTT are the evidence team leads for the PCOS Guideline update. CTT and LP developed the search strategy. KT and TC performed the search, screening, and risk of bias assessments. KT performed the data extraction. KT and AM performed GRADE assessments. All authors interpreted results. KT drafted the first version of the manuscript, which was revised by all authors. All authors critically reviewed and approved the final version of the manuscript for publication.

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Conflicts of Interest

No conflicts of interest.

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