Review Article

Laser and light based treatments of acne

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ABSTRACT

Medical treatments for acne vulgaris include a variety of topical and oral medications. Poor compliance, lack of durable remission, and potential side effects are common drawbacks to these treatments. Therefore, there is a growing demand for a fast, safe, and side-effect–free novel therapy. Acne often improves after exposure to sunlight, and this has led to the development of laser and other light therapies resulting in the overall ease of treatment, with minimal adverse effects. A variety of light and laser devices has been used for the treatment of acne, including the potassium titanyl phosphate laser, the 585- and 595-nm pulsed dye lasers, the 1450-nm diode laser, radiofrequency devices, intense pulsed light sources, and photodynamic therapy using 5-aminolevulinic acid and indocyanine green. These devices are thought to target the underlying pathogenic factors such as propionibacterium acnes colonization, increased sebaceous gland activity, and the cutaneous inflammatory response. In this article, we review the current status of light- and laser-based treatment of acne.

Key words: Acne, laser, light, photodynamic therapy

INTRODUCTION

Acne vulgaris is a multifactorial skin disorder of pilosebaceous unit significantly associated with psycho-social comorbidites. Acne is treated with a variety of topical and oral medications such as antibacterials, antimicrobials and retinoids. Conventional treatments for acne can be prolonged and associated with side-effects. This has prompted a search for more acceptable therapies. Acne often improves after exposure to sunlight, and this observation has led to the development of laser and other light therapies over two decades, laser and light sources are given in combination with oral and topical treatments or as an alternate regimen. Till date, the trials of lasers and light therapy have been small and the results conflicting. However' in this article we discuss the recent updates regarding the use of lasers and light therapy in treating acne vulgaris.

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PATHOGENESIS OF ACNE

Acne is a chronic inflammatory disease of pilosebaceous units and the major factors involved in the pathogenesis are increased sebum production, hypercornification of the pilosebaceous duct, abnormality of the microbial flora, especially ductal colonization with *Propionibacterium acnes (P. acnes)* and inflammation. Recent molecular and clinical studies have advanced knowledge in areas such as sebocyte biology,[1] the role of androgens,[2] hyperkeratinization,[3] dietary factors,[4] and the effect of cytokines and toll-like receptors,[5] leading to the identification of potential new targets for acne therapy.

TREATMENT WITH LASER AND LIGHT-BASED THERAPIES

Lasers/light-based devices may offer an alternative to conventional acne modalities in selected patients, such as non-responder or noncompliant patients or in antibiotic resistance patients. Over almost a century, many types of light sources were introduced to treat or improve acne symptoms. These light sources include fluorescent, halogen, xenon, tungsten lamps, and recently lasers. The devices used to treat acne may be separated into groups based on approach; namely

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devices that directly or indirectly target *P. acnes* are UVA/UVB, blue light, blue and red light combination, devices that alter the sebaceous gland structure include aminolevulinic acid (ALA) and photodynamic therapy (PDT), infrared lasers, radiofrequency, and devices that exert an effect on both are pulse dye laser (PDL), potassium titanyl phosphate (KTP) laser target, intense pulsed light (IPL)[6] [Table 1].

TARGETING *P. ACNES*

P. acnes which is implicated in the pathogenesis of acne is a gram positive microaerophilic skin bacterium. As a part of its normal metabolic and reproductive processes, it produces and accumulates endogenous porphyrins, namely protoporphyrin, uroporphyrin, and coproporphyrin III.[7] These porphyrins absorb light energy at the near-ultraviolet (UV) and blue light spectrum. Exposure to absorbed light wavelengths induces these photosensitizers to generate highly reactive free radical species, which subsequently cause bacterial destruction.[8,9] The singlet oxygen formed in the reaction is a potent oxidizer that destroys lipids in the cell wall of *P. acnes*.[10] Although absorption and photodynamic excitation are most efficient between the wavelengths of 400 and 430 nm, with enough light, the reaction may be initiated with a variety of different wavelengths. Many light sources may affect *P. acnes* including narrowband light sources, IPL devices (broadband light), KTP lasers (532 nm), PDLs (585-595 nm), and various orange/red light lasers or light sources (610-635 nm); as these light sources have wavelengths that correspond to an absorption peak of *P. acnes* porphyrins.

UVA/UVB

70% of patients report improvement in their acne after sunlight exposure,[11] but it was not clear until recently which wavelengths contribute to this favorable effect, UV, visible light, or the combination of both. UVA and UVB treatment was found to have a marginal beneficial effect, but it is potentially carcinogenic.[12]

Table 1: Lasers and target

Target	Laser
P. acne	UVA/UVB, blue light, blue and red light combination
Sebaceous gland	Aminolevulinic acid (ALA) and photodynamic therapy (PDT), infrared lasers, radiofrequency
P. acne and Sebaceous gland	Dye laser (PDL), potassium titanyl phosphate (KTP) laser target, intense pulsed light (IPL)

BLUE LIGHT AND RED LIGHT

Blue light has the most effective visible wavelength for photoactivation of endogenous porphyrin component of *P. acnes* because the 407- to 420-nm band has the strongest porphyrin photoexcitation coefficient.

However, blue light has poor depth of skin penetration.[10] Red light, however, in addition to its deeper penetration up to the sebaceous glands,[13] may have anti-inflammatory properties by influencing cytokine release from macrophages.[14] Research has shown *in vitro* that the viability of *P. acnes* relates inversely to light intensity. According to an action spectrum for the inactivation of *P. acnes*, the sensitivity of *P. acnes* is highest for shorter wavelengths and decreases with increasing wavelength.[15]

There are several studies showing the efficacy of blue light, and combination of both blue and red light for the treatment of mild to moderate acne [Table 2]. Most of the studies were open label with sample size ranging between 30 to 50 patients. The results uniformly showed short term improvement in inflammatory lesions with blue light. Further none of the studies has showed follow up results beyond 12 weeks after treatment. Acne clearing is variable among patients and relapse rates are high after therapy is discontinued.[16-24] We have quoted two studies of combination of blue-red light therapy and one of them show that combination is superior to blue light alone [Table 2].

LASERS:

KTP

The 532 nm green light pulsed laser therapy has been tried as it penetrates deeper than blue light and activates porphyrins to target *P. acnes*. It is well tolerated and causes non-specific collateral thermal injury to sebaceous glands. KTP has been shown to have short-term effects on improving acne severity with minimal side effects, Baugh *et al.*,[25] in a trial evaluated twenty-six subjects, with moderate facial acne. They concluded that use of the KTP 532 nm laser for the treatment and management of acne vulgaris is both safe and effective, with positive results enduring up to four weeks post-treatment.

Another prospective split-face study involving 11 patients using KTP laser by Bowes *et al.*, showed a 36% decrease in mild-to-moderate acne lesion count versus a 2% increase in the control group after 1 month. A 28% decrease in sebum production but

Table 2: Studies on the use of blue light and combination of blue and red light for mild to moderate acne vulgaris

Study and design	Sample size light	Treatment area	No. of treatments	Results	Follow-up period	Adverse effects
Tzung *et al.*[17] randomized split face in facial acne	*n*=31	On one side of the face and other side serving as control	2 sittings/wk for 4 wks Total: 8 sittings	Significant improvement with light vs no treatment (P <0.0001) Worsening of nodulocystic nodules with light treatment	1 month	
Elman and Lask[18] 3 small studies combined	*n*=46 in all 3 studies High-intensity (405-420 nm)	Face Split-face dose-response Full-face open trial Split-face, double-blind controlled	2 sittings/wk for 8-15 min per sitting Total: 8 sittings	Overall 80% response Significant reduction (59%-67%) of inflammatory lesions; prolonged remission for 8 wk after therapy	2 months	None reported
Tremblay *et al.*[19] open label in mild-moderate acne	*n*=45 High-intensity blue light (415 nm and 48 J/cm^2)		2 sittings/wk for 20 min per sitting Total: 8-16 sittings	9 patients completely cleared; 50% of patients highly satisfied Significant improvement on global improvement scoring system	2 months	None reported
Morton *et al.*[20] open label in mild-moderate acne	*n*=30 LED light source (409-419 nm at 40 mW/cm^2)	Facial acne	8 sittings in 4 wks for 10-20 min per sitting	Reduction in inflammatory lesions apparent at wk 5 but statistically significant at wk 8	3 months	Mild and self limited
Omi *et al.*[21] open label in facial acne	*n*=28 High-intensity Narrow band blue light (420 nm)	Facial acne	2 sittings/wk For 15 min per sitting Total: 8 sittings	Overall 64.7% Improvement in acne lesions; No bacterial changes on PCR or culture	2-3 months	-
Kawada *et al.*[22] open label of mild-moderate acne	*n*=30 High-intensity Narrow band blue light (407-420 nm)	Facial acne	2 sittings/wk For 15 min per sitting Total: 10 sittings	64% Reduction of acne lesions;	-	Dryness reported by two patients
Papageorgiou *et al.*[23] randomized open label in mild-moderate acne	*n*=104 Groups: (1) blue light; (2) mixed blue and red light; (3) cool white light; (4) 5% BPO	Facial acne	everyday for 12 wks	76% Improvement in inflammatory lesions and 58% improvement in comedones in blue-red light Blue Red light mix statistically superior to other treatments	3 months	No significant short term side effects
Seung Yoon Lee *et al.*[24] Mild to moderately severe acne	*n*=24 quasimonochro-matic LED devices, alternating blue (415 nm) and red (633 nm) light	Facial acne	-	Improvement in non-inflammatory and inflammatory lesions were 34.28% and 77.93%, Brightened skin tone and improved skin texture were spontaneously reported by 14 patients		No side effects

minimal effect on *P. acnes* (measured by fluorescent photography) was also noted.[26]

Another study by Yilmaz *et al.*,[27] to evaluate the efficacy and safety of 532-nm KTP laser and compare the effects of once and twice weekly applications in the treatment of mild to moderate acne vulgaris was conducted on 38 patients They concluded that 532-nm KTP laser treatment may be an alternative method in selected acne vulgaris patients with no significant difference noted between once and twice weekly applications.

PDL

585-nm PDL that targets oxyhemoglobin has also been investigated for treatment of acne. It causes selective photothermolysis of the dilated vascular component of inflammation associated with acne. Through the delivery of coherent yellow light, porphyrins are activated to produce phototoxic effects.

Seaton *et al.*,[28] demonstrated a 49% reduction in inflammatory lesion counts versus 10% in controls 12 weeks after treatment using a 585 nm PD. Compared to controls, almost half of the treated

patients (regardless of severity at baseline) had a 50% reduction in lesion counts by 12 weeks. In a randomized blinded placebo-controlled trial of 26 patients with mild-to moderate acne, Orringer *et al.*,[29] showed only a trend towards improvement with the laser treated side that was not statistically significant.

Another study by Seaton *et al.*,[30] with pulsed dye laser showed no effect on the degree of *P. acnes* colonization or sebum production as measured by the standardized application of absorptive tape. This study found a significant upregulation of transforming growth factor β, which are a potent stimulator of neocollagenesis and a potent inhibitor of inflammation. Thus, the efficacy of this laser on inflammatory acne is likely through its local anti-inflammatory effects.

The 595-nm pulsed dye laser has also been used in conjunction with the 1450-nm diode laser to treat both acne vulgaris and post-inflammatory erythema resulting from acne. In one non controlled study by Glaich *et al.*,[31] of 15 patients the lesions counts dropped by a mean of 52%, 63%, and 84% after 1,2, and 3 treatments, respectively ($P < 0.01$). In addition to improvements in acne and acne scarring, significant improvement in post-inflammatory erythema was also noted and was attributed to the selective photothermolysis of vessels by the pulsed dye laser. Although the combination of the two lasers may provide better targeting of different pathophysiologic contributors to acne, the authors did not know whether the improvement is greater than that achieved with either the pulsed dye laser or the 1450-nm diode laser alone.

A randomized controlled single-blinded trial was conducted to assess the efficacy of an adjuvant PDL treatment when combined with a proven topical treatment [fixed-combination clindamycin 1%-benzoyl peroxide 5% hydrating gel) in 80 patients. The findings did not support the concept of a substantial benefit of PDL treatment in acne vulgaris.[32]

At low, nonpurpuric fluences, this laser can also reduce inflammatory acne. The effect of this laser on acne improvement was believed to be mediated by decreasing *P. acnes* or sebaceous gland activity. Although studies suggest promise, conclusions are not possible because of the varying regimens and methodologies used.

TARGETING SEBACEOUS GLANDS:

Sebum plays an important role in acne, therapies targeting the gland with the goal of reduction in size and sebum output has resulted in acne improvement.

INFRARED LASERS

Infrared lasers were developed for non-ablative facial skin rejuvenation; they have become one of the most effective, novel acne treatments available due to their depth of penetration into the dermis. Although the distribution of sebaceous glands is highly variable in the dermis, infrared lasers target water, which is the dominant chromosphere in the sebaceous gland. The laser light selectively produces an injury zone in the dermal layer where sebaceous glands are located and causes enough injury to arrest the over production of sebum, thereby eliminating acne.[10] The lasers at 1,450 nm and 1,540 nm have been used for this purpose.

1450-NM DIODE LASER

This device can cause thermal coagulation of the sebaceous lobule and associated hair follicle through peak thermal heating of the upper to mid dermis up to a depth of 500 μm.[13] The presumed mechanism of acne improvement is through heating of the sebaceous gland and associated structures resulting in reduced sebaceous gland activity resulting in a reduction in inflammatory acne lesions. Treatment with the infrared 1450-nm diode laser with a dynamic cooling device has been shown to safely and effectively reduce inflammatory acne lesions of the face with fluences as high as 14 J/cm^2. The first report of the efficacy of this laser in the treatment of acne was an uncontrolled pilot study where 19 patients with inflammatory acne, many of whom were refractory to traditional medical treatment, underwent three treatments at four to six week intervals using a fluence of 14 J/cm^2. The decrease in lesion counts from baseline was 37% after the first treatment, 58% after the second treatment, and 83% after the third treatment. Pain was well tolerated, and adverse effects were limited to transient erythema and edema at treatment sites.[33]

A subsequent study on 20 patients was done to evaluate long-term improvement in inflammatory acne after cessation of laser treatments. A reduction of 76.1% from baseline was sustained 12 months after the third and final laser treatment which helped demonstrate

that the 1450-nm diode laser provides a long-term remission in acne, sebum production, as measured by Sebutape scores corroborating the hypothesis that the mechanism of this laser involves reduced sebaceous gland activity.[34]

1540-NM ERBIUM GLASS LASER

A single study has also shown efficacy of the 1540-nm erbium glass laser for treatment of acne. After four treatments at four-week intervals, a 78% reduction in acne lesions and decreased skin oiliness was noted in 25 patients.[35]

Similar results (82% decreased lesion count at three months) were reported by Kassir *et al.*,[36] in 20 patients (skin phototypes I–IV) with facial acne who received four bi-weekly treatments. Patients in both trials reported decreased oiliness of the skin and no immediate or delayed adverse effects were reported in either study.

Another study by Angel *et al.*,[37] was performed to investigate the effects of this laser on active lesions of the face and of the back at the two-year follow-up. The mean percent reduction was 71% at the six-month follow-up, 79% at the one-year follow-up and 73% at the two-year follow-up. Furthermore, this longer follow-up study demonstrates long-term acne clearing.

A study by Bogle *et al.*,[38] was performed on 15 patients with moderate to severe acne with 1,540- on the face four times at 2-week intervals. Treatment of inflammatory facial acne with this laser showed improvement of 68%, but sebum measurements did not change.

INTENSE PULSED LIGHT

Unlike a laser, an intense pulsed light source provide a noncoherent (500 to 1200 nm) source of intense light that can be modified by filters to provide irradiation with specific wavelengths of light. The use of intense pulsed light for the treatment of acne has been theoretically based on the production of singlet oxygen after photoactivation of porphyrins synthesized and stored by *P. acnes*.[39] Broad spectrum delivery by IPL devices is believed to lead to photothermolysis, where the absorption of light by endogenous chromophores in the skin creates enough heat and energy to target the blood vessels that supply sebaceous glands in order to reduce sebum production. Several studies have utilized intense pulse light sources after topical application of porphyrins. In one study of intense pulsed light, patients with mild to moderate acne were treated using wavelengths between 430 and 1100 nm. Reductions of 79% and 74% were noted in non-inflammatory and inflammatory lesions, respectively, one month after the final treatment.[40]

Current studies using IPL as an anti-acne therapy have led to mixed results. Kanwna *et al.*,[41] evaluated the efficacy and safety of IPL on acne vulgaris in Asian skin in 25 patients. He showed short-term improvement in both inflammatory and non-inflammatory acne lesions using IPL alone. After the first exposure, numbers of non-inflammatory and inflammatory acne lesions decreased to 36.6 and 43.0%, respectively, of their pretreatment values. After five treatments, they decreased to 12.9 and 11.7%, respectively, of their pretreatment values. Others have shown that IPL alone and IPL with photodynamic therapy significantly reduced the number of non-inflammatory, but not inflammatory lesions.[42] In comparison with other light sources, IPL was less effective at reducing acne lesions than pulsed dye lasers but more effective than blue-red combination light-emitting diodes.[43] With the adverse effects of pain, swelling, erythema, blistering, and crusting[39] and its doubtful efficacy it is unclear of the usefulness of IPL in future of acne therapy.

RADIOFREQUENCY

Reductions in perifollicular inflammation and sebaceous gland is the presumed mechanism of action A combined radiofrequency and pulsed light has been used to treat acne. Twice-weekly treatments for four weeks resulted in reduction of mean acne lesion counts by 47% in 32 patients.[44] Adverse effects were limited to temporary erythema, tingling and burning. Another study of 22 patients using a monopolar radiofrequency device showed greater than 75% reduction in inflammatory acne lesions in more than 90% of patients after one treatment session.[45]

PHOTODYNAMIC THERAPY

PDT involves the application of ALA, which, when taken up by the pilosebaceous units, is metabolized through the heme synthesis pathway to produce protoporphyrin IX which when photoactivated, the resultant singlet oxygen and free radicals produced

Table 3: Studies on the use of photodynamic therapy for acne vulgaris

Study	Type of acne	Sample size	Agent and Incubation time	No. of treat-ments	Light source	Results	Follow-up	Adverse effects
Itoh *et al.*,[50] open-label, uncontrolled study	intractable facial acne	*n*=13	20% delta-aminolaevulinic acid 4 hrs	1	polychromatic visible light Halogen (600-700 nm)	New lesions reduced 1, 3, 6 mo after treatment; improved facial appearance; temporary edematous erythema, epidermal exfoliation; acne lesions returned in 6 mo	6 m	Immediate-discomfortburning and stinging erythema for 3 days epidermal exfoliation from 4th to 10th day
Goldman and Boyce;[51] open-label, uncontrolled study	mild-moderate facial acne	*n*=22	ALA 15 minutes	2	Blue (417 nm)	32% (ALA PDT) vs 25% (light only) improvement; 68% (ALA PDT) vs 40% (light only) reduction in papule counts;	2 weeks	No significant adverse events
Gold *et al.*[52]	moderate-severe facial inflammatory acne	*n*=19	20% 5-ALA 15-30 minutes	4 sittings (Once in every 15 days)	Pulsed light source (420-950 nm)	55% Reduction in inflammatory lesions; 38% reduction in noninflammatory lesions	2 m	-
Hongcharu *et al.*,[48] open-label study 4.sites: 1.ALA+red light; 2.ALA alone; 3.light alone; and 4.untreated control.	mild-moderate back acne	*n*=22,	20% ALA 3 hours under occlusion	1 sitting in 50% 4 sittings in 50%	Broadband (550-700 nm)	clinical and statistically significant clearance of inflammatory acne by ALA+red light for at least 20 wk after multiple treatments and 10 wk after a single treatment.	20 weeks	Transient hyperpigmentation, superficial exfoliation, and crusting
Taub[53]	moderate-severe acne	*n*=18	ALA 15-30 minutes	2-4 sittings over 4-8 weeks	Blue or 580-1000 nm with RF	11 of 12 patients with improvement had 50% improvement 5 had >75% improvement	4 m	Erythema and peeling for up to 5 days
Alexiades-Armenakas[54]	mild-severe facial acne		ALA 45 minutes	Mean 2.9, range 1-6	LP PDL (595 nm)	Clearance in all patients	Mean 6.4, range 1-13	
Horfelt *et al.*,[55] prospective, randomized, blinded placebo-controlled multicenter study	Moderate inflammatory facial acne	*n*=30	MAL 3 hours	2 sittings 2 weeks apart	Red (635 nm)	63% Reduction at 6 wk in inflammatory lesion counts (vs 28% placebo); 54% reduction at 12 wk (vs 20% placebo)	3 m	Pain, erythema, and skin swelling
Wiegell and Wulf,[56] randomized, controlled, investigator-blinded study	mild-moderate inflammatory acne	*n*=15,	ALA vs MAL 3.hours (light impermeable dressing)	1	Red (635 nm)	59% Median reduction in inflammatory lesions in both treatment groups	3 m	Severe pain during illumination, erythema, pustular eruptions, and epithelial exfoliation after treatment more severe in ALA group

Contd...

Table 3: Contd...

Study	Type of acne	Sample size	Agent and Incubation time	No. of treat-ments	Light source	Results	Follow-up	Adverse effects
Wiegell and Wulf,[57] (randomized, controlled, investigator-blinded study	moderate-severe facial acne	*n*=36 MAL=21 control=15 (no treatment)	3 hours	2 sittings (2 weeks apart)	Red	68% Reduction in inflammatory lesions (MAL) vs no change in control, no reduction in noninflammatory lesions	3 m	moderate to severe pain during treatment severe erythema, pustular eruptions, epithelial exfoliation. 7 patients did not receive second treatment because of adverse events
Yeung *et al.,*[58] randomized, split-face open-label study	moderate acne	*n*=30, 3.groups PDT+IPL IPL alone, Control (No treatment)	16% MAL 30 minutes	4 sittings (3 week intervals)	IPL (530-750 nm)	At 12 wks, reduction of inflammatory lesions 65% in PDT group, 23% in IPL group, and 88% in control Reduction of non-inflammatory lesions 38% in PDT group and 44% in the IPL group, increase of 15% was noted in the control	3 m	25% of patients in PDT group withdrew because of intolerance to procedure-related discomfort
Horfelt *et al.,*[59] open, unblinded study dose-response study:	mild-severe acne, face and back	*n*=15	20%ALA 3 hours	1 sitting	Red light (635 nm) from a Waldman PDT 1200 lamp (varying doses based on anatomic area and severity of acne)	By patient assessment, 8 improved after treatment; Percentage improvement not reported	10 weeks	Hyperpigmentation and pain more common with higher doses of light
Taub,[60] randomized, open-label study	moderate-severe facial acne	*n*=22	5-ALA 3 hours	3 sittings (2 week intervals)	3 sources IPL alone600-850 nm(or) IPL (or 580-980 nm) + RF(or) blue light (417 nm)	Responses to IPL greatest and more consistent than RF-IPL or blue light	3 m	-
Haedersdal *et al.,*[61] split-face, open-label study	mild-moderate acne	*n*=15, LP PDL vs LP PDL+PDT	MAL 3 hours	3 sittings	Long-pulsed dye laser	PDT with Long PDL improved both inflammatory and noninflammatory lesions to a greater degree than PDL alone	3 m	Erythema, edema, and pustular eruptions intensified from MAL incubation
Orringer JS *et al.,*[62] randomized, controlled, split-face, single-blind clinical trial	Facial acne	*n*=44	5-ALA 60-90 minutes	3 sittings	pulsed dye laser	30% improvement in inflammatory lesions and 7% in non-inflammatory lesions	-	-
Jang MS *et al.,*[63] prospective, single-blind, clinical trial	Mild to moderate facial acne	*n*=34	IAA ICG	5 sittings 1 week interval	IAA with green light (520 nm) on one half and with ICG with near-infrared radiation (805 nm) on the other half.	Both ICG-PDT and IAA-PDT showed better responses for inflammatory lesions than for noninflammatory lesions	3 m	Less side effects when compared to ALA/MAL
Tuchin *et al.,*[64] Pilot study	Facial/Back acne	*n*=22	ICG (1 mg/ml) 5 or 15 minutes	1 sitting	Near-infra red laser diode light (803-809 nm)	decreased the number of active elements, erythema and inflammation,	1-2 m	No side effects

ALA - 5: Aminolevulinic acid, IPL- intense pulsed light, LP PDL: Long-pulsed pulsed dye laser, MAL: Methyl aminolevulinate, PDT: Photodynamic therapy, RF: Radiofrequency, ICG: Indocyanine green, IAA: Indole-3-acetic acid

are cytotoxic. This results in not only death of *P. acnes* but also damage to the pilosebaceous unit itself.[13,46-48]

PDT requires 3 factors, a photosensitiser, light and oxygen. The commonly used photosensitizers are 5-aminolevulinic acid or, methylaminolevilunate (MAL) and the newer ones are Indocyanine green (ICG) and Indole-3-acetic acid. Sources of light used are light emitting diodes, fluorescent lamps, IPL (filtered xenon flashlamps) filtered incandescent or arc lamps, lasers and sunlight. There are certain variables that influence *P. acnes* photo inactivation which include concentration of porphyrins, (depending on type of acne lesion), effective fluence, wavelength of emitted photons, temperature at which the reaction is carried out and tissue oxygen availability.[49]

Various studies have been conducted using PDL with ALA, MAL and ICG.[48,50-64] [Table 3] Most of the studies and their data are short term and data limited. More controlled trials are required to rationalize the results. However the data below shows that inflammatory lesions respond better to the various light sources of PDT in cases of mild to moderate acne.

CONCLUSIONS

Laser and light-based acne treatments can be an alternative to medical treatment for non responders and is associated with minimal adverse effects. These devices also offer an option for those patients who have moderate to severe acne but are concerned about oral medications because of potential adverse effects. Long-term improvements have been documented with laser treatments. However, low powered visible light sources alone achieve mild acne improvement but the patient might be able to use the light in combination with a topical medication, thus avoiding the need for an oral antibiotic. The acne clearance produced by devices targeting *P. acnes* is generally short-lived and requires continued follow-up treatments. Devices that target sebaceous glands are all effective to varying degrees based upon the principle of selective damage to the sebaceous gland. And though this temporary alteration may be sufficient to decrease sebum production and result in long-term acne clearance, studies have yet to demonstrate sebaceous gland ablation. More clinical studies are needed to determine its efficacy and safety in different acne symptoms in a larger set of patients and in longer follow-up periods. Future advances in laser technology may improve both the efficacy and safety of lasers for the treatment of acne vulgaris and will make laser and light based treatments an attractive and cost-effective option for patients with acne.

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Multiple Choice Questions

1. The laser/light sources against *P. acne* include all except
   a. Blue light – 407-420 nm b. Diode laser -810 nm
   c. KTP 532 nm d. Erbium Glass -1540 nm
2. The porphyrin responsible for photoactivation following photodynamic therapy is
   a. Protoporphyrin I b. Protoporphyrin IX
   c. Coproporphyrin I d. Coproporphyrin III
3. The sensitivity of *Pacnes* is highest with
   a. longer wavelength b. shorter wavelength
   c. Maximum absorption of light d. Minimum absorption of light
4. The sources of light/laser that targets sebaceous gland
   a. Blue light b. Blue and red light
   c. Photodynamic therapy d. Ultra violet light
5. Which among these are not a photosensitiser for PDT
   a. 5-aminolevulinic acid b. Methyl amino levulinate
   c. 8-amino levulinic acid d. Indole 3 acetic acid
6. The target chromophore for PDL in acne is
   a. Oxyhemoglobin b. Water
   c. Porphyrins d. Methhemoglobin
7. The photosensitisers in PDT may be administered in following ways
   a. Topical applications only b. Both topical and systemic
   c. Intralesional administration d. Both topical and intralesional methods
8. IPL is believed to help in reduction of acne by all except
   a. Production of singlet oxygen b. Photothermolysis,
   c. Reduce sebum production d. Destruction of sebaceous glands
9. The thermal coagulation of 1450nm Diode laser reaches to which of the following levels
   a. Epidermis b. Mid dermis
   c. Deep dermis d. Subcutaneous tissue
10. The factors involved in the mechanism of action of PDT in acne are all except
    a. Photosensitiser b. Light source
    c. Water d. Oxygen

Answers:
1. b, 2. b, 3. b, 4. c, 5. c, 6. a, 7. a, 8. d, 9. b, 10. c