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Efficacy and safety of 1064 nm long-pulsed neodymium-doped yttrium garnet (Nd:YAG) laser for treating acne vulgaris: a prospective clinical trial

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Background: Acne vulgaris is a common chronic inflammation of pilosebaceous units with a multifactorial pathogenesis. Traditional treatment may have limited success with potential side effects. The long-pulsed neodymium-doped yttrium garnet (Nd:YAG) laser may be a desirable alternative.

Methods: A prospective clinical trial was conducted on 61 acne patients at the Department of Dermatology, Basrah Teaching Hospital, from April 2019 to April 2020. Three treatments with long-pulsed Nd:YAG were performed across two-weeks intervals (fluence 50 J/cm2, spot size 5 mm, pulse duration 15 ms, and frequency 1.5 Hz). Patients were assessed at baseline and 2, 4, 6, and 12 weeks later by counting the acne lesions and scoring the response according to the percentage of lesions' reduction.

Results: Sixty-one patients completed the study (49 females and 12 males); the mean age was 18.7 ± 1.67 years. A significant reduction of acne lesions at the end of therapy was observed compared to the baseline. The mean number of total lesions was reduced from 84.2 ± 25.8 to 16 ± 23.3 ($P < 0.05$). Overall, 49 (80.3%) patients achieved an excellent response, 3 (4.9%) good, 1 (1.6%) moderate, and 8 patients (13.1%) showed a poor response. The treatment was well tolerated with insignificant adverse effects.

Conclusion: Long-pulsed Nd:YAG laser is an effective and safe modality for treating acne vulgaris and may be considered an alternative option for cases of recurrence after conventional treatment. However, more sessions are needed for severe cases.

Keywords: long-pulsed Nd:YAG, laser, acne, treatment

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INTRODUCTION

Acne vulgaris is a common chronic inflammatory skin disease of the pilosebaceous unit. It is considered one of the most prevalent global diseases and is a common cause of dermatological consultation [1]. Most acne cases begin in the prepubertal period when androgens begin affecting the pilosebaceous unit. Both ovarian and testicular androgen have a major role in acne pathogenesis [2] in addition to plugging of the pilosebaceous units and *Cutibacterium* (formerly known as *Propionibacterium*) *acne* overgrowth [3,4], resulting in characteristic acne lesions [5] that include comedones, papules, pustules, and, less commonly, nodules, cysts, and scarring [6]. Several modalities of treatment have been used for acne vulgaris; however, conventional therapy such as topical and systemic therapy is characterized by poor compliance and efficacy, lack of long-lasting remission, high cost, recurrence, and several

side effects [7]. Therefore, a new effective and safe treatment modality is needed.

Acne treatment with light-based devices and lasers shows a different degree of efficacy. The long-pulsed 1064 nm neodymium-doped yttrium garnet (Nd:YAG) laser introduces selective heat into the dermis [8]. It has been successfully used in the treatment of a variety of conditions such as varicose veins, rhytids, photo epilation, and removal of pigmented lesions [9-11], and more recently for collagen remodeling [12]. Its target chromospheres are melanin, hemoglobin, and water. The laser deeply penetrates the lower dermal layer, reaching the pilosebaceous unit and creating diffuse heating of the dermis and selective photothermolysis of the overactive sebaceous glands. This minimizes the sebum activity and *C. acne* population, thereby reducing the inflammatory acne lesions without damaging the epidermis [13]. In the literature, a few studies have been published that address the efficacy of the 1064 nm long-pulsed Nd:YAG in the treatment of acne scars with encouraging results [14,15]. However, its effects on active acne lesions are not well investigated, and the evidence-based research on its use is limited and primarily based on case reports or case series studies. Therefore, this study aimed to assess the efficacy and safety of the 1064 nm long-pulsed Nd:YAG laser in treating acne vulgaris in a cohort of young adult patients.

PARTICIPANTS AND METHODS

Participants and study design

A prospective clinical trial was conducted on 66 young patients with acne at the Department of Dermatology, Basra Teaching Hospital, Basrah, Iraq, from April 2019 to April 2020. According to the Lehman grading system, patients were clinically diagnosed and scored as mild, moderate, and severe [16]. A detailed history was taken from each patient focusing on the following points: age, sex, duration of the illness, family history, menstrual history for females, and previous treatments, if any. Physical examination was performed, including the site, number, and types of lesions.

Inclusion criteria were patients aged more than 17 years diagnosed with acne of various severity who either recurred after repeated courses of conventional treatments and looking for alternative therapy or those who did not receive any treatment in advance and asked for laser therapy for their acne. Exclusion criteria were nodulocystic acne, coexisting skin diseases, history of photosensitivity, pregnant and lactating women, prior therapy with isotretinoin within the last six months, and use of systemic antibiotics or topical acne preparations within one month. Patients were not allowed to use topical, systemic, or other light-based acne treatments during the study.

Eligible patients were treated with the 1064 nm long-pulsed Nd:YAG laser (Quanta system, new Q- Plus *1, made in Italy). Device settings were as follows: fluence 50 J/cm^2, spot size 5 mm, pulse duration 15 ms, and frequency 1.5 Hz. The device is equipped with an active contact cooling system. On a fortnightly interval, three treatments were performed over the entire face without topical anesthesia in a one-pass stamping technique, side by side without overlapping. Topical emollient and sunscreen cream were applied immediately after the session. Upon completion of three sessions, there was a follow-up eight weeks later.

Clinical assessment

The trial's primary endpoint was the percentage of patients who achieved at least 80% or more reduction in the total number of acne lesions. The patients were assessed at the baseline visit and during each subsequent treatment session using the following parameters:

1. Numerical counting of the acne lesions, performed by an independent, qualified dermatologist using the photographs snapped by Galaxy Note 5 phone camera (16 Megapixels) for every patient at baseline and at the follow-up visits.
2. Compared to the baseline value, we calculated the percentage of the total reduction of acne lesions.
3. We graded the response according to the percentage of the total reduction of acne lesions using the following scale [17]: ≥ 80% reduction (excellent response), 60–79% reduction (good response), 40–59% reduction (moderate response); < 40% reduction (poor response).
4. We monitored for any side effects at each visit.
5. At the end of the study, patients' satisfaction

and their attitude toward the treatment were assessed using a three-point scale: 0 = unsatisfied, 1 = partially satisfied, 2 = fully satisfied.

Ethical considerations

Before beginning the laser sessions, personal consent was taken from each patient after fully explaining the nature and method of laser treatment, the duration of follow-up, and anticipated complications. The trial was approved by the Ethical Committee of Basrah College of Medicine (Approval No: 03040853-2020).

Statistical methods

Data analysis was performed using IBM SPSS version 25. Means ± standard deviation (SD) was used for descriptive data; frequencies with the percentage used to describe the quantitative data. The one-way ANOVA (analysis of variance) test was used to analyze any significant differences between the results of treatment sessions. *P*-values below 0.05 were considered significant.

RESULTS

Out of the 66 patients enrolled, 61 completed the study (49 females and 12 males). The mean age was 18.7 ± 1.67 (range:16–22) years. Other demographic characteristics are shown in Table 1.

The mean ± SD of the total lesions for all patients was significantly reduced from 84.2 ± 39.6 at the baseline to 16 ± 23.3 at the end of the trial ($P < 0.05$) (Table 2; Figure 1).

The mean ± SD of comedones was significantly reduced from 6.7 ± 5.7 to 1.54 ± 2.2 at the end of the trial ($P < 0.05$), and the inflammatory lesions also showed a remarkable and significant reduction; papular and pustular lesions were reduced from 56 ± 23 and 19.2 ± 12.1 to 10.9 ± 16 and 2.94 ± 4.5, respectively ($P < 0.05$).

Table 3 shows a significant reduction in the percentage of acne lesions after the first session, with a gradual escalation in subsequent sessions (56% cumulative reduction of comedones, 82% clearance of papules, and 84% of pustules at the end of the trial).

Table 4 indicates that 49 patients (80.3%) achieved an excellent response, with an ≥ 80% reduction of total acne lesions (Figure 2) and good or partial response was seen in 3 patients (4.9%) (Figure 3). In contrast, 8 patients (13.1%) were classified as poor responders (Figure 4); 87.5% of them were severe

Table 1. Demographic characteristics of patients with acne vulgaris (n = 61)

Variable	Frequency (%)
Sex	
Female	49 (80.3%)
Male	12 (19.7%)
Marital status	
Married	3 (4.9%)
Single	58 (95.1%)
Positive family history	27 (44.2%)
Fitzpatrick skin phototype	
Type II	12 (19.6%)
Type III	39 (63.9%)
Type IV	10 (16,3%)
Treatment-naïve	9 (14.8%)
Previous treatment	52 (85.2%)
Severity	
Mild	2 (3.3%)
Moderate	47 (77%)
Severe	12 (19.7%)

Table 2. Number of acne lesions (mean ± SD) at baseline as well as after each session and during the follow-up period

Lesion	Baseline	1st session	2nd session	3rd session	Follow-up
Total	84.2 ± 39.6 CI (74.1–94.4)	53.2 ± 25.8 CI (46.6–59.8)	37 ± 23.3 CI (31.05–43)	22.4 ± 22.1 CI (16.7–28)	16 ± 23.3 CI (10.–21.9)
Comedones	6.7 ± 5.7 CI (5.3–8.2)	4.8 ± 4.6 CI (3.6–6)	3.4 ± 3.5 CI (2.5–4.3)	2.1 ± 2.5 CI (1.5–2.8)	1.5 ± 2.2 CI (0.9–2.1)
			P< 0.05		
Papules	56 ± 23. CI (49.8–62.1)	36.63 ± 18.1 CI (32–41.2)	25.4 ± 16.9 CI (21.1–29.8)	15.5 ± 16.0 CI (11.4–19.6)	10.9 ± 16.1 CI (6.7–15.1)
			P< 0.05		
Pustules	19.2 ± 12.1 CI (16–22.3)	11.9 ± 7.8 CI (9.8–13.9)	8 ± 5.8 CI (6.4–9.5)	4.7 ± 4.7 CI (3.4–1.7)	2.9 ± 4.5 CI (5.9–4.1)
			P< 0.05		

Abbreviations: SD: standard deviation, CI: confidence interval

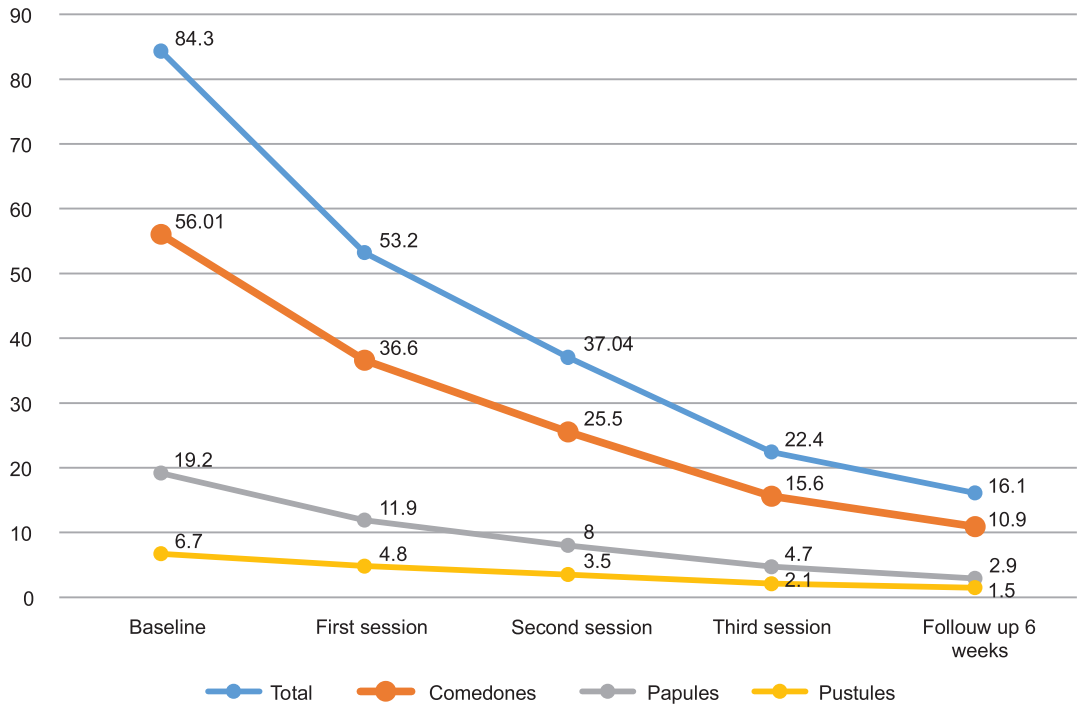


Figure 1. Line chart of the mean acne lesions at the baseline as well as after each session and during the follow-up(six weeks) period

Table 3. Percentage of reduction of total acne lesions during each session and the follow-up period compared to the baseline value

Type of lesion	Percentage of reduction				
	1st session	2nd session	3rd session	After 6 weeks	*P*-value
Total	35.4%	55.3%	72.9%	80.5%	< 0.005
Comedones	26%	42%	56%	56%	
Papules	36%	55%	73%	82%	
Pustules	39%	58%	74%	84%	

Table 4. Scoring the patients' responses according to percentage of total reduction in acne lesions by the end of the trial

Percentage of the total reduction in acne lesions	No (%)
≥ 80% (excellent response)	49 (80.3)
60–79% (good response)	3 (4.9)
40–59% (moderate response)	1 (1.6)
< 40% (poor response)	8 (13.1)

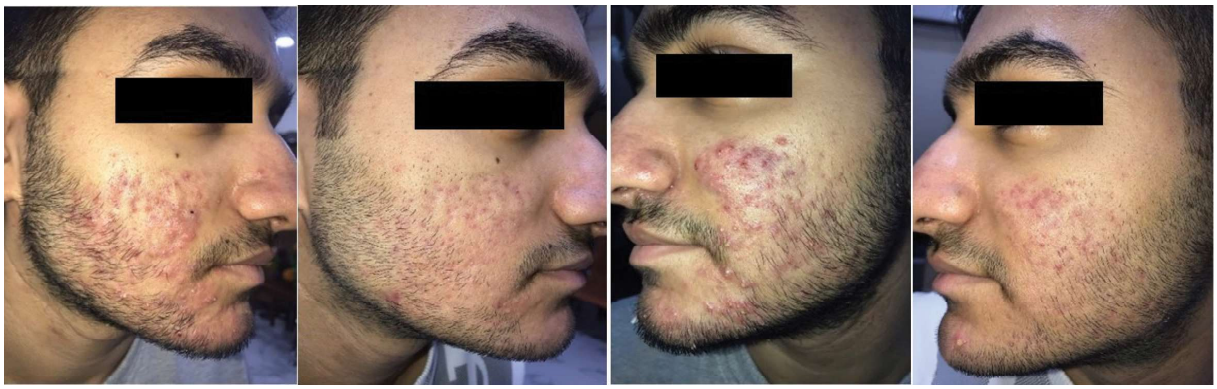
types with III and IV Fitzpatrick skin phototypes.

Twenty-five patients (41%) developed mild erythema that faded within a few hours after treatment, and 28 patients (45.9%) experienced mild transient pain at the moment of treatment. No pigmentary changes, burns, or blistering was seen after the therapy.

Forty-nine (81%) patients were fully satisfied with the improvement achieved, while 2 (3%) were partially satisfied and 10 (16%) were unsatisfied.

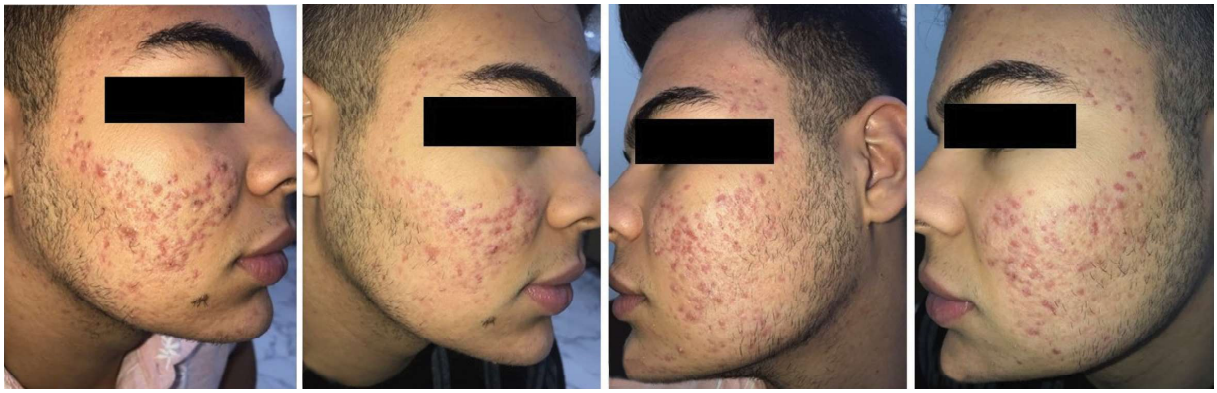
DISCUSSION

Acne vulgaris is a common skin disease among adolescents. In Iraq, the prevalence rate of acne vulgaris is 73% in men and 62% in women; it is associated with long-term sequelae like scarring, post-inflammatory hyperpigmentation, and adverse psychological effects [18]. Laser- and light-based therapies are currently considered an alternative modality for acne vulgaris treatment, especially for those with a contraindication to classic anti-acne treatment. Moreover, these new modalities can bypass issues in traditional acne treatment, such as teratogenicity and antibiotic resistance [19]. In acne vulgaris, the light-based therapies with blue and red light, in addition to intense pulsed light, target the porphyrins produced by *C. acne* with a resultant toxic effect on these bacteria. However,



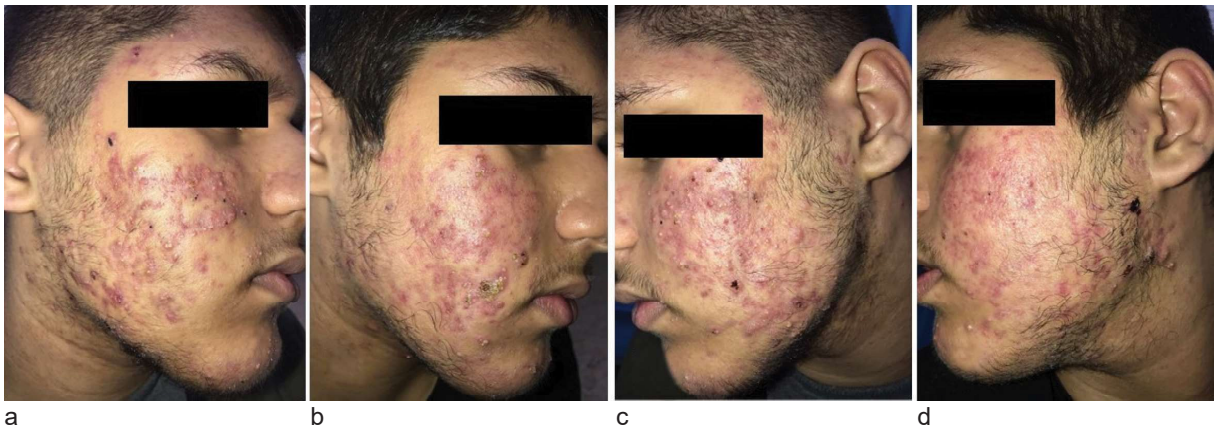
a b c d

Figure 2. A 19-year-old male patient with moderate acne at baseline (a, c), showed an excellent response (b, d) following three sessions of laser treatment



a b c d

Figure 3. An 18-year-old male patient with moderate acne at baseline (a, c), showed a partial response (b, d) following three sessions of laser treatment



a b c d

Figure 4. A 20-year-old male patient with severe acne at baseline in (a, c) showed a poor response (b, d) following three sessions of laser treatments

because these modalities do not target the sebaceous glands, the recurrence rate is high [20]. Lasers with a wavelength near the infra-red spectrum produce selective photothermolysis that damages the sebaceous glands and subsequently decreases sebum production and *C. acne* density [21]. Several

laser modalities with this spectrum, such as 1320 nm Nd:YAG [22], 1450 nm diode lasers [23], and 1540 nm erbium lasers [24], are used for acne vulgaris treatment. In addition to their effect on improving inflammatory acne lesions, these lasers have been shown to improve acne scars [25].

Although the 1064 nm long-pulsed Nd:YAG laser's proposed mechanism of action in treating acne lesions is not completely understood, it may be related to the aforementioned selective photothermolysis of the sebaceous glands and a decrease in the *C. acne* population, in addition to the effect on inflammation by reducing TLR 2, IL8, and TNF-alpha levels [26].

In this study, we demonstrated that the 1064 nm long-pulsed Nd:YAG laser is an effective therapeutic modality for acne patients, with successful clearance of more than 80% of total acne lesions in 80.3% of cases after three treatment sessions. Even more importantly, perhaps, the response was sustained and continued throughout the six-week follow-up period with no sign of relapse.

At first, Robin successfully treated four cases with mild and moderate acne with remarkable improvement after one session of 1064 nm long-pulsed Nd:YAG laser with no significant side effects apart from mild erythema. He also found an additional effect of the laser in the improvement of acne scars [27], while Ruta *et al.* used the long-pulsed Nd:YAG laser to treat 19 patients with mild to moderate acne vulgaris across five weekly sessions. They reported a 75% reduction in acne lesions in a patient with the mild to moderate type [15]. Mohamed *et al.* reported comparable improvements using either intense pulsed light (IPL) or long-pulsed Nd:YAG in treating mild to severe acne in a face-split design study. They reported a 67.1% and 70.2% reduction in inflammatory lesions for the IPL and 1064 nm long-pulsed Nd:YAG laser, respectively [27]. In this study, we have the advantage of a larger number of patients compared to other studies and the need for a small number of treatment sessions to achieve significant clinical and durable improvement of acne lesions. The difference between the results of various studies may be related to different demographic features of the candidate patients, laser device settings, total number of laser sessions, and the time interval between each session.

Although 80.3% of patients achieved an excellent response, 8 (13.1%) patients were considered poor responders—they showed less than 40% reduction of their acne lesions despite rigorously adhering to scheduled sessions. Moreover, their demographic criteria were comparable to that of the responders. Despite the interpersonal variation in response to the laser treatment, severe acne is likely less responsive than mild or moderate acne, and additional laser sessions may be required. Accordingly, we were unable to perform additional sessions for these patients because of the citywide lockdown during the COVID-19 pandemic. The pandemic also affected the number and period of follow-up of our patients.

There are certain limitations to this study. It was an uncontrolled, non-comparative, single-arm clinical trial, which may impede the precision of our conclusions. The possibility of confounders such as sex, age, occupation, and environmental factors were not accounted for while analyzing our data. Finally, our findings are based on evidence from a single-center study.

CONCLUSION

In conclusion, the 1064 nm long-pulsed Nd:YAG laser is a safe and effective alternative treatment modality for mild to moderate acne vulgaris and offers a sustained and durable effect; however, severe acne was less responsive. Further evidence on the safety and efficacy of the 1064 nm long-pulsed Nd:YAG in treating acne vulgaris needs to be confirmed in controlled clinical trials, especially for severe acne, while accounting for the impact of confounding factors.

Conflict of Interest: None declared.

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