Journal of Pakistan Association of Dermatologists. 2024;**34(4)**:836-845.

Original Article

Treatment of cutaneous leishmaniasis with long-pulsed Nd:YAG laser in comparison with intralesional sodium stibogluconate or ciprofloxacin

Khalil I. Al-Hamdi[1], Anwar Qais Saadoon[2]

[1]Department of Dermatology, Basra Medical College, University of Basra, Basra, Iraq.
[2]Department of Dermatology, Al-Mudaina General Hospital, Basra, Iraq.

Abstract

Objective Cutaneous leishmaniasis (CL), a significant public health issue, is caused by a parasitic infection. This research aimed to assess the effectiveness and safety of long-pulsed Nd:YAG laser therapy in treating CL, and to compare its outcomes with treatments using intralesional sodium stibogluconate and 0.2% ciprofloxacin.

Methods In this study, 26 patients with a total of 73 cutaneous leishmaniasis lesions were divided into three groups for treatment. Group one, with 28 lesions, received long-pulsed Nd:YAG laser therapy. Group two, comprising 19 lesions, was treated with intralesional sodium stibogluconate, while group three, with 26 lesions, received intralesional 0.2% ciprofloxacin. Treatment efficacy was categorized into four levels: mild, moderate, marked, and complete clinical response. Treatments occurred bi-weekly over six weeks, followed by a three-month post-treatment follow-up to check for any complications.

Results Twenty-six patients with 73 cutaneous leishmaniasis lesions participated. Among them, 18 (69.2%) were male, and 8 (30.8%) were female. The treatment success rates were 82.1% for long-pulsed Nd:YAG laser, 78.9% for intralesional sodium stibogluconate, and 84.6% for intralesional ciprofloxacin. Throughout the treatment and follow-up period, no significant side effects or complications were observed in any of the three groups.

Conclusion Long-pulsed Nd:YAG laser seems to be comparable to both intralesional sodium stibogluconate and intralesional 0.2% ciprofloxacin in the treatment of cutaneous leishmaniasis.

Key words
Cutaneous leishmaniasis; Nd:YAG laser; Sodium stibogluconate; Ciprofloxacin.

Introduction

Cutaneous leishmaniasis (CL), a parasitic skin condition caused by flagellated protozoa from the Leishmania genus,[1,2] is a significant health issue in various countries. About 1.5 million new cases of this disease occur annually.[2,3]

Diagnosing CL clinically is straightforward when a patient, residing in or having recently visited an endemic area, presents with a characteristic skin lesion (a non-healing violaceous nodule or ulcer lasting four to six weeks or more).[4] Although many therapeutic methods have been tested for treatment of cutaneous leishmaniasis with varying degrees of success, it is conspicuous that the currently available treatments for this disease are far from satisfactory.[5-16]

Manuscript Received on: November 29, 2023
Revised on: January 01,2024
Accepted on: Apr 26, 2024
Address for correspondence
Dr. Anwar Qais Saadoon, MBChB, FICMS (D&V)
Division of Dermatology,
Al-Mudaina General Hospital, Basra, Iraq.
Ezzedine Salim Subdistrict, 61012, Basra, Iraq
Ph: 009647822432200,

For a long time, many types of lasers have been employed in treating CL, including CO2 lasers, pulsed dye lasers (PDL), erbium glass lasers, and argon lasers, with a reported high efficacy and minimum side effects.[1] The neodymium-doped yttrium aluminum garnet (Nd:YAG) laser is a solid-state laser in which a crystal of yttrium aluminum garnet is used as a laser medium, producing an Nd:YAG laser that has a long wavelength of 1064 nm.[17] This wavelength, which is in the near infrared range, enables this type of laser to penetrate deep into the skin, creating a heat that destroys the diseased cells.[18] This type of laser is absorbed mainly by hemoglobin and, to a lesser extent, by water and melanin; this makes the Nd:YAG laser a very versatile laser, with a wide spectrum of applications in dermatology.[17,18] Long-pulsed Nd:YAG laser has minimal side effects. It may cause pain, which is greatly controlled by cooling; however, topical anesthesia may be required in some cases. Pain may be more intense when a large spot size is used.[18] Recently, the effect of long-pulsed Nd:YAG laser on leishmaniasis has been studied.[19,20] However, data about clinical effect of long-pulsed Nd:YAG laser therapy on CL are still limited. The objective of this research was to assess the effectiveness and safety of long-pulsed Nd:YAG laser therapy for CL treatment, comparing its performance with intralesional sodium stibogluconate and intralesional 0.2% ciprofloxacin in managing this condition.

Methods

This study is an open-label, comparative, therapeutic clinical study. The sample of this study was comprised of patients who were all clinically diagnosed by the same dermatologists in the Division of Dermatology and Venereology at Al-Sadr Teaching Hospital in Basra, Iraq, between January 2019 and May 2020. Patients were confirmed by histopathologic examination as suffering from cutaneous leishmaniasis. A total of 31 patients, with a combined total of 86 lesions of cutaneous leishmaniasis, were enrolled in this study. Five patients, with a combined total of 13 lesions, were defaulted because of the COVID-19 pandemic and the lockdown measures. As a result, only 26 patients, with a combined total of 73 lesions, completed the study.

A comprehensive history was gathered from every patient. Questions in the history inquired into the name, age, address, occupation, total number of lesions, duration of each lesion, associated symptoms, previous treatment for the lesions, recurrence of the lesions, family history of the same lesions, past medical and drug history, and obstetric history (in the case of female patients of reproductive age). A thorough physical examination was performed for each study participant, inspecting the lesion, specifically examining the sites, type of lesions (ulcerative or non-ulcerative), erythema, discharge or pus, swelling of the lesions, and palpation of each lesion to assess the lesion's induration and tenderness. The regional lymph nodes were also palpated for any lymphadenopathy. After the clinical diagnosis of the patient's condition, the diagnosis was confirmed in every patient by histopathologic demonstration of the Leishman-Donovan body in one of the lesions (if multiple) by incisional biopsy. Biopsies were taken from the edge of the lesions, stained by haematoxylin and eosin in addition to Geimsa stains, and examined by an expert pathologist.

Patients meeting the following criteria were not included in the study: the immunosuppressed; those with prolonged use of corticosteroid; patients with chronic conditions such as diabetes mellitus, and those with impaired peripheral circulation; those with peripheral neuropathy; those who were pregnant; those who were breastfeeding; those with remarkable regional lymphadenopathy (an indication for systemic

therapy); those with lesions affecting certain areas, such as the ears, mucosa, or the periocular area; patients with lesions more than 5 cm in diameter (an indication for systemic therapy); those who had received previous local or systemic therapy for their lesions; those experiencing re-infection; and those with lesions lasting more than 12 weeks in duration (since there's a chance of spontaneous recovery during the follow-up phase).

Prior to starting treatment, informed consent was acquired from every participant or from the patient's parents in cases where the patient was under 15 years old. This was done after thoroughly explaining the disease's nature, progression, potential complications, and prognosis to them or their parents; the treatment modalities and possible side effects; and the need for taking a photograph at the beginning of every treatment session and follow-up visit. Ethical approval for this study was granted by the scientific committee of the Scientific Council of Dermatology and Venereology at the Iraqi Board for Medical Specializations.

Seventy-three lesions were randomly assigned to three groups by a simple randomization method. Assignment was done by writing the name of the three therapeutic methods on equal-sized pieces of white paper. Papers were folded equally and mixed well with each other, then one of these papers was chosen by lottery for every identified lesion of typical cutaneous leishmaniasis on the patient's body in order to assign the lesions into three groups according to type of treatment: (1) Group A: treated by long-pulsed 1064-nm Nd:YAG laser: Twenty-eight lesions were treated with long-pulsed 1064 nm Nd:YAG laser by using a Quanta System-Q Plus Series Laser, made in Italy. The following parameters were used: the fluence (amount of laser energy delivered per unit area): 200 mj/cm^2, spot size (laser beam diameter) 3 mm, and pulse duration (duration of laser exposure) 20 ms. Each lesion was eligible for up to three treatment sessions for six weeks, on a fortnightly schedule. If the patient had two or more lesions, one lesion was randomly selected to be treated with laser, and this lesion was marked by a marker with the letter 'N'. It was then measured and photographed with the back camera of an iPhone 11 Pro Max with 12-megapixel resolution. Throughout the treatment session, the patient and all staff in the operating room used laser safety goggles specific to the wavelength for eye protection. The lesion was treated by a maximum of three passes of laser, with a 1-mm margin around the advancing edge. In cases where the patient felt pain during the initial session, a topical anesthetic cream (EMLA cream) was applied to the lesion one hour before laser therapy in the following sessions. After the laser treatment, povidone iodine (10%) was dabbed over the lesion, and then a dressing was applied for one day. (2) Group B: treated by intralesional sodium stibogluconate (Pentostam®): Nineteen lesions were treated by Pentostam® (100 mg/ml). If the patient had two or more lesions, one of the lesions was randomly selected to be treated with Pentostam®, and this lesion was marked by a marker with the letter 'P', then measured and photographed with the same camera mentioned above. After that, povidone iodine was dabbed over the lesion, and then the lesion was infiltrated by 0.2 ml of Pentostam® for each 1 cm^2 all around the advancing edge of the lesion and from all sides (five sites/ lesion) until the whole lesion was blanched. At the end of the treatment session, povidone iodine was dabbed over the lesion, and then a dressing was applied for one day. The process was repeated every two weeks for six weeks. (3) Group C: treated by intralesional ciprofloxacin: Twenty-six lesions were treated by intralesional ciprofloxacin 2 mg/ml. For those patients who had two or more lesions, one lesion was randomly selected to be injected with 0.2% ciprofloxacin, and this lesion was marked by a

marker with the letter 'C', and then its diameter was measured and a clear photo was taken of the lesion. Subsequently, povidone iodine was dabbed over the lesion and the lesion was infiltrated by 0.2 ml of ciprofloxacin for each 1 cm^2 all around the advancing edge of the lesion and from all sides (five sites/ lesion) until whole lesion was blanched. At the end of each treatment session, povidone iodine was dabbed over the lesion, and then a dressing was applied for one day. The process was repeated at two-week intervals for up to six weeks.

In each of the three groups, patients were examined in the first visit, and again in subsequent visits every two weeks, for up to six weeks; there was then a follow-up visit after three months following the end of the treatment sessions, to monitor for any complications. In the first and subsequent visits, the lesions in all three groups were assessed for the following: determination of the baseline color and the change in color in subsequent visits; measurement of the color diameter, and determination of any change in the color diameter on subsequent visits; palpation and marking of each lesion for induration and measurement of its diameter, with determination of any change in the diameter of the induration on subsequent visits; and detection of any ulcer or crust, and measurement of their diameter (if any), along with a determination of the change in the diameter of the ulcer/crust on subsequent visits. For round and regular lesions, the diameter, color, induration, and any ulcer or crust were recorded. In contrast, for irregular lesions, the longest and widest parts were measured to determine the mean. On every visit, a colored photograph was taken for every lesion, all from the same distance and with the same light exposure, using the back camera of an iPhone 11 Pro Max with a 12-megapixel resolution. "Sharquie's modified Leishmania score to assess the objective response to topical and systemic therapy"[16] was used to assess the objective response to treatment in each group **(Table 1)**.

At the end of each treatment session, any complications or side effects of the treatment (in any of the three groups) were noted and recorded. Data were coded and entered into a computer for statistical analysis using SPSS (Statistical Package for the Social Sciences), version 26. Data presentation included mean, standard deviation (±SD), and percentages. To compare the mean response scores across the three groups at each visit, ANOVA and Tukey's HSD tests were utilized. The Chi-square test compared response percentages between the three groups at each visit and the scarring percentage in clinically cured patients. A p-value of less than 0.05 was deemed to indicate statistical significance.

Table 1 Sharquie's modified leishmania score to assess the objective response to topical and systemic therapy. [20]

Score	*Change in the color of lesion*	*Reduction rate in the color diameter of lesion*	*Reduction rate in the induration of lesion*	*Reduction rate of the ulcer/crust*
4	Bright red	-	-	-
3	Red	0%–25%	0%–25%	0% –25%
2	Dusky red	25%–50%	25%–50%	25%–50%
1	Dark brown	50%–75%	50%–75%	50%–75%
0	Light brown	>75%/clearance	>75%/clearance	>75%/clearance

- For ulcerative lesions, a score of 12–16 = mild response; a score of 8–12 = moderate response; a score of 4–8 = marked response; a score of 0–4 = complete clearance
- If the lesion was not ulcerative, the fourth parameter (reduction rate of ulcer/crust diameter) was not applicable, so grading was done as follows: a score of 9–12 = mild response; a score of 6–9 = moderate response; a score of 3–6 = marked response; a score of 0–3 = complete response.
- Both marked and complete responses were considered as having been cured.

Table 2 The means and standard deviations of total score of response to the therapy within each group according to the time of the visits

Groups	*First visit*	*After 2 weeks*	*After 4 weeks*	*After 6 weeks*
Group A(Mean±SD)	14.46±2.219	12.25±2.757	9.11±3.645	4.86±2.321
P-value*		<0.0001	<0.0001	<0.0001
Group B (Mean±SD)	14.89±2.025	12.95±2.272	9.37±3.876	5.05±2.697
P-value*		<0.0001	<0.0001	<0.0001
Group C (Mean±SD)	14.42±2.062	11.92±2.171	8.92±2.058	4.50±2.874
P-value*		<0.001	<0.0001	<0.0001
P- value	0.962	0.379	0.902	0.770

* Paired samples t-test was used to compare the mean of the score of response of the baseline visit with the subsequent visits in each group.

Results

Twenty-six patients with a combined total of 73 lesions of cutaneous leishmaniasis completed the present study. Eighteen (69.2%) of the patients were males and the remaining eight (30.8%) were females. The ratio of male to female was 2.25:1. Ages ranged from five to 65 years, with a mean±standard deviation (SD) of 30.27±14.23 years. Regarding the number of lesions, two (7.7%) patients had a single lesion; 24 (92.3%) patients had multiple lesions. Out of the 73 lesions, 57 (78.1%) of the lesions were ulcerative and 16 (21.9%) of the lesions were nonulcerative. The duration of the lesions ranged between 2 and 11 weeks, with a mean±SD 6.73±2.24 weeks. The lesions mainly presented on the upper extremities (42 lesions, 57.6%), while other sites involved were the lower extremities (23 lesions, 31.5%), the head and neck (five lesions, 6.8%), and the trunk (three lesions, 4.1%).

The mean therapeutic responses to therapy from the baseline visit through six weeks of therapy in each group are summarized in **Table 2**, while the grades of responses to therapy in the three groups are summarized in **Table 3** and **Figure 1** according to the time of visits.

From the aforementioned results, the cure rates (marked and complete clinical response) were 82.1%, 78.9%, and 84.6% for long-pulsed 1064 nm Nd:YAG laser, intralesional sodium stibogluconate, and intralesional 0.2% ciprofloxacin, respectively. In all three groups, every lesion that was clinically cured exhibited post-inflammatory hyperpigmentation **(Figures 2-3)**. Apart from pain at the time of treatment application, mild edema, and erythema after the treatment session, no severe local or systemic side effects were noted in any patient treated with any of the three methods. No complications were recorded during the follow-up period.

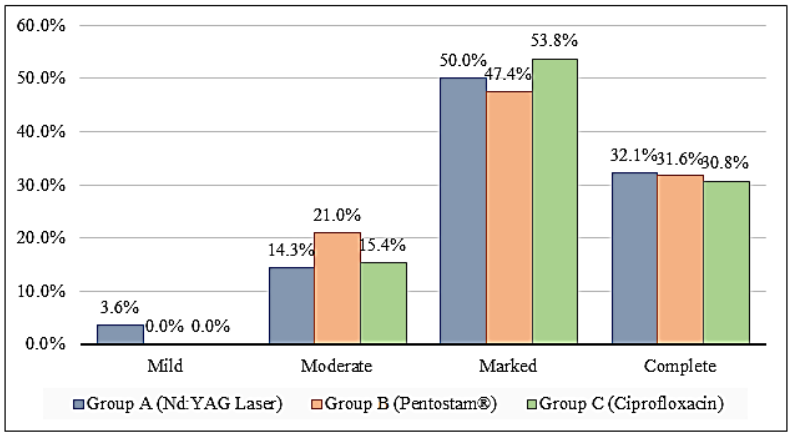

Figure 1 The grades of response in the three groups over six weeks of treatment.

Table 3 The grades of responses in the three groups according to the time of visits.

Visit	*Response*	*Group A Number (%)*	*Group B Number (%)*	*Group C Number (%)*	*P-value**
Two weeks	Mild	21 (75)	15 (78.9)	19 (73.1)	0.756
	Moderate	6 (21.4)	4 (21.1)	7 (26.9)	
	Marked	1 (3.6)	0 (0)	0 (0)	
	Complete	0 (0)	0 (0)	0 (0)	
Four weeks	Mild	7 (25)	6 (31.6)	6 (23)	0.963
	Moderate	13 (46.4)	8 (42.1)	10 (38.8)	
	Marked	6 (21.5)	3 (15.8)	7 (26.9)	
	Complete	2 (7.1)	2 (10.5)	3 (11.5)	
Six weeks	Mild	1 (3.6)	0 (0)	0 (0)	0.915
	Moderate	4 (14.3)	4 (21)	4 (15.4)	
	Marked	14 (50)	9 (47.4)	14 (53.8)	
	Complete	9 (32.1)	6 (31.6)	8 (30.8)	
Cure rate		23 (82.1)	15 (78.9)	22 (84.6)	
Total		28 (100)	19 (100)	26 (100)	

Table 4 The comparison between the three groups regarding the percentages of scarring in the clinically cured lesions at the end of treatment.

Parameters	*Group A Number (%)*	*Group B Number (%)*	*Group C Number (%)*	*P-value*
Heal without scar	8 (34.7)	4 (26.6)	7 (31.8)	0.871
Heal with minimum scar	15(65.3)	11 (73.4)	15 (68.2)	

In comparing the three groups regarding the mean score of response to therapy, there was no significant statistical difference at two weeks (p-value=0.379), four weeks (p-value=0.902), and six weeks of therapy (p-value=0.77), as determined by a one-way ANOVA test **(Table 2)**. In comparing the three groups regarding the grade of response, there was also no significant statistical difference at two weeks (p-value=0.756), four weeks (p-value=0.963), and six weeks of therapy (p-value=0.915) **(Table 3)**. Regarding the complete response after six weeks of therapy, the results were comparable in all three groups: nine lesions (32.1%) in group A (long-pulsed Nd:YAG laser), six lesions (31.6%) in group B (intralesional Pentostam®), and eight lesions (30.8%) in group C (intralesional 0.2% ciprofloxacin) **(Table 3** and **Figure 1)**. At the end of the treatment, the clinically cured lesions in the three groups showed variable percentages of scarring; however, there was no significant statistical difference between the groups **(Table 4)**.

Discussion

Cutaneous leishmaniasis (CL) is a parasitic disease endemic in Iraq and many other countries, causing a public health problem worldwide.[3,5] Although it is a self-limited disease, it is nevertheless very annoying and may cause significant scarring and disfigurement, leading to psychological trauma in many patients.[21] Furthermore, it may take from several months to several years to heal. Therefore, treatment is essential in many situations, particularly if the lesions present on cosmetically significant locations.[2] Treatment of the lesions may shorten the course of the disease and may prevent cutaneous scarring and disfigurement.[22]

On review of the literature, one finds that a long list of topical and systemic therapies have been used for this disease, with varying degrees of success;[23] however, there is no consensus as to the best therapeutic option for this parasitic infection.[5-16] Treatment of CL with topical

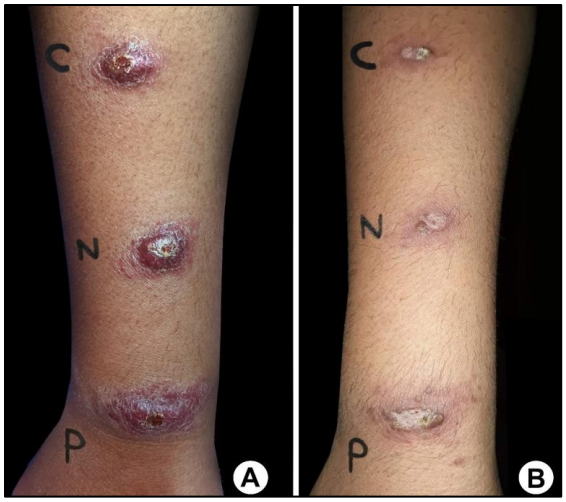

Figure 2 A 35-year-old female patient with 3 lesions of CL, one of them treated with intralesional 0.2% ciprofloxacin (marked with the letter 'C'), the second treated with Nd:YAG laser (marked with the letter 'N'), and the third treated with intralesional Pentostam® (marked with the letter 'P'). (A) Before the treatment and (B) after 6 weeks of therapy.

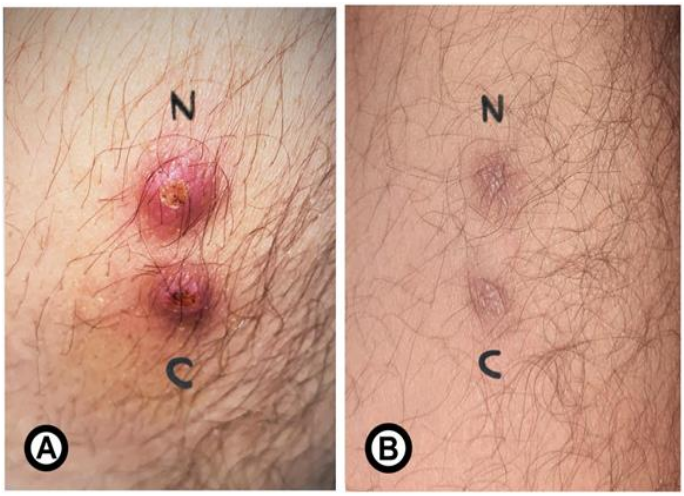

Figure 3 A 37-year-old male patient with 2 lesions of CL, one of them (marked with the letter 'N') treated with Nd:YAG laser and the second one (marked with the letter 'C') treated with intralesional 0.2% ciprofloxacin. (A) Before the treatment and (B) after 6 weeks of therapy.

therapy is an attractive therapeutic option, especially when there are few lesions. This may enhance the effectiveness of the drug by increasing its concentration at the lesional site. Furthermore, this method may reduce the cost and systemic side effects of the treatment.[16]

Many intralesional therapies have been investigated for treatment of CL;[11,12] however, bearing in mind the fact that intralesional therapies are invasive and may cause significant pain, decreasing the frequency of administration or searching for other effective, noninvasive, and less-painful methods is required. In recent years, the use of laser therapy is increasing in dermatology.[1,17,18] Different types of lasers have been used for treatment of different skin conditions, including CL.[1] The present work compares the clinical effect of long-pulsed Nd:YAG laser in the treatment of CL with intralesional sodium stibogluconate and with intralesional 0.2% ciprofloxacin, all on a fortnightly schedule.

Long-pulsed Nd:YAG laser with a 1064-nm wavelength is one of the commonly used lasers in the field of dermatology.[17,18,24] Recently, the effect of long-pulsed Nd:YAG laser on Leishmania subspecies has been studied.[19] Presumably, Nd:YAG laser destroys the parasite by thermal effect.[19] However, data concerning the clinical effects of long-pulsed Nd:YAG laser on the lesions of CL are still limited. To the best of our knowledge, a single study has been carried out to study the clinical effects of long-pulsed Nd:YAG laser on CL lesions.[20]

In 2019, Omidian, *et al*.[20] compared the effects of long-pulsed Nd:YAG laser with intralesional meglumine antimoniate on 16 patients with a combined total of 32 lesions of CL. Some of the lesions were treated with intralesional meglumine antimoniate and some were treated with long-pulsed Nd:YAG laser. The following laser parameters were used: fluence of 200 mj/cm^2, pulse duration of 20 ms, and spot size of 3 mm. The laser was applied on a fortnightly schedule until complete recovery of the lesions.

The mean number±SD of laser sessions was 2.56±0.89, while the mean number±SD of meglumine antimoniate injections was 7.31±4.01 (p-value <0.001).[20] The cure rate of long-pulsed Nd:YAG laser or intralesional meglumine antimoniate was not calculated in the Omidian, *et al*. study. The present study showed that the use of long-pulsed Nd:YAG laser with the same above-mentioned parameters for the treatment of CL at two-week intervals for six weeks results in a cure rate of 82.1%, with no significant side effects apart from pain that can be controlled by topical anesthesia. This confirms the observation of Omidian, *et al*. that long-pulsed Nd:YAG laser is an effective and safe modality of treatment when used for treatment of CL at two-week intervals with the above parameters.

Intralesional sodium stibogluconate (Pentosam®) is a widely used antimonial drug. It has been proven successful in treatment of CL and it is currently considered the first-line treatment for localized CL;[25] however, it is painful, expensive, and resistance to this therapy has been recorded in several countries.[11] Moreover, it is not universally available. Previous studies have shown that the cure rate of this drug ranges from 68% to 100%;[26-28] however, there is no consensus on its efficacy at different schedules of administration. In an attempt to decrease the frequency of administration of this drug, intralesional Pentostam® has been administered on a fortnightly schedule and the results were compared to long-pulsed Nd:YAG laser and intralesional 0.2% ciprofloxacin. The present work showed that the cure rate of the fortnightly administered Pentostam® for CL after six weeks of starting therapy was 78.9%, which was lower than in the Sharquie, *et al*. study, where intralesional sodium stibogluconate used for treatment of CL at eight-day intervals had a cure rate of 94.6% within six weeks of therapy.[26] These results suggest that the eight-day schedule may be superior to the fortnightly schedule in treatment of CL.

Intralesional ciprofloxacin is a cheap and available drug used for the treatment of CL as an alternative to antimony; however, data about its efficacy in comparison with other modalities are still limited. Based on our knowledge, only two studies have explored the use of intralesional 0.2% ciprofloxacin in treating CL. Al-Hamdi, *et al*. (2010) found that intralesional 0.2% ciprofloxacin was as effective as intralesional 7% hypertonic sodium chloride solution in the treatment of CL [12]. In the Al-Hamdi, *et al*. study, intralesional 0.2% ciprofloxacin was used to treat 27 CL lesions, compared with 21 lesions of CL treated with intralesional 7% hypertonic sodium chloride. The cure rate of intralesional hypertonic saline was 76.2%, while the cure rate of intralesional 0.2% ciprofloxacin was 81.5%.[12] This result is comparable with the cure rate of intralesional 0.2% ciprofloxacin in the current study (84.6%).

In Pakistan, Arshad, *et al*. (2011)[29] compared the use of intralesional 0.2% ciprofloxacin for the treatment of CL with intralesional meglumine antimoniate, and they found that the cure rates were 84.38% and 93.33% respectively. Although the injections were given at five-day intervals, the cure rate of intralesional 0.2% ciprofloxacin in the Arshad, *et al*. study (84.38%) was very close to the cure rate of the same drug in the present study (84.6%). This may indicate that the fortnightly schedule used in the present work is as effective as the five-day schedule used in Arshad, *et al*. study; thus, we propose that additional injections of intralesional 0.2% ciprofloxacin do not seem to improve the cure rate. Furthermore, short intervals between the injections do not seem to increase the cure rate of intralesional 0.2% ciprofloxacin. On the other hand, the scoring system and the method of assessment of the response to therapy were

different in the present study from those in the Arshad, *et al*. study. Therefore, it may be unfair to compare the cure rates of the two studies.

Conclusion

Long-pulsed Nd:YAG laser therapy seems to be comparable to both intralesional sodium stibogluconate and intralesional 0.2% ciprofloxacin in the treatment of CL on a fortnightly schedule. Although it may be costly, the fact that the Nd:YAG laser treatment is noninvasive and apparently safe, without significant side effects, may make it an attractive alternative therapeutic option for CL, especially in patients who have trypanophobia or those who reject injections for any reason. Nevertheless, conducting well-controlled clinical trials with a larger sample size and extended follow-up period is recommended to draw more definitive conclusions.

Declaration of patient consent The authors certify that they have obtained all appropriate patient consent.

Financial support and sponsorship None.

Conflict of interest Authors declared no conflict of interest.

Author's contribution

KIA: Substantial contributions to study design and acquisition of data, manuscript writing and critical review and has given final approval of the version to be published.

AQS: Substantial contributions to data collection and interpretation, manuscript writing and revision and has given final approval of the version to be published.

References

1. Siadat AH, Zolfaghari A, Shahmoradi Z, Shariat S, Sohrabi K. Application of laser for treatment of cutaneous leishmaniasis: A review of literature. *Lasers Med Sci*. 2020;**35(7)**:1451-7.
2. Sharquie KE, Noaimi AA, Al-Ghazzi AG. Treatment of cutaneous leishmaniasis by topical 25% podophyllin solution (single, blinded, therapeutic, controlled study). *J Dermatol Dermatol Surg*. 2015;**19(2)**:108-13.
3. Bravo FG. Protozoa and Worms. In: Bolognia JL, Schaffer JV, Cerroni L (Eds). Dermatology. 4th ed. Elsevier; 2018.1470-1502.
4. Downing C, Tyring S. Parasitic diseases. In: Griffiiths CE, Barker J, Bleiker T (Eds). Rook's textbook of dermatology. 9th ed. West Sussex:Wiley Blackwell; 2016.1016-9.
5. Naif A, Hasan H, Kadhim K. Metronidazole versus Pentostam for treatment of cutaneous leishmaniasis. *Gazz Med Ital*. 2018;**177(11)**:611-6.
6. Al-Heany AR, Sharquie KE, Al-Najar SA, *et al*. Cutaneous leishmaniasis: Comparative techniques for diagnosis. IOSR J Dent Med Sci. 2014;**13**:33-7.
7. Malek JM, Ghosn SH. Leishmaniasis and other protozoan infections. In: Goldsmith LA, Katz SI, Gilchrest BA, *et al.* (Eds). Fitzpatrick's dermatology in general medicine. 8th ed. New York: The McGraw-Hill Companies; 2012:2526-44.
8. Sharquie KE, Noaimi AA, Saleh BA. Cutaneous leishmaniasis as imitator of skin diseases and a diagnostic challenge. *J Cosmet Dermatol Sci Appl*. 2018;**8**:158-77.
9. Eiras DP, Kirkman LA, Murray HW. Cutaneous leishmaniasis: current treatment practices in the USA for returning travelers. *Curr Treat Options Infect Dis*. 2015;**7(1)**:52–62.
10. Waller DG, Sampson AP (Eds). Medical pharmacology and therapeutics. 5th ed. Elsevier; 2018.
11. Aronson N, Herwaldt BL, Libman M, *et al.* Diagnosis and treatment of leishmaniasis: Clinical practice guidelines by the Infectious Diseases Society of America (IDSA) and the American Society of Tropical Medicine and Hygiene (ASTMH). *Am J Trop Med Hyg*. 2017;**96(1)**:24-45.
12. Al Hamdi K, Awad AH, Moker HM. Evaluation of intralesional 0.2% ciprofloxacin as a treatment for cutaneous leishmaniasis. *East Mediterr Health J*. 2010;**16(1)**:89-93.
13. Sharquie KE. A new intralesional therapy of cutaneous leishmaniasis with hypertonic sodium chloride solution. *J Dermatol*. 1995;**22(10)**:732-7.

14. Sharquie KE, Najim RA, Farjou IB. A comparative control trail of intralesional administrated zinc sulfate, hypertonic saline chloride and pentavalent antimony compound against acute cutaneous leishmaniasis. *Clin Exp Dermatol*. 1997;**22(4)**:169-73.
15. Al-Waiz M, Sharquie KE, Al-Assir M. Treatment of cutaneous leishmaniasis by intralesional metronidazole. *Saudi Med J*. 2004;**25**:1512-3.
16. Sharquie KE, Noaimi AA, Sharara ZA, Saleh B, Al-Salam W. Topical therapy of acute cutaneous leishmaniasis using zinc sulphate solution 25% versus podophyllin solution 25%. *J Cosmet Dermatol Sci Appl*. 2017;**7(03)**:258-74.
17. Kaufman J. Nd:YAG laser. In: Bard S, Goldberg DJ (Eds). Laser treatment of vascular lesions. *Basel: Karger*. 2014:94–106.
18. Steiner R. Basic laser physics. In: Raulin C, Karsai S (Eds). Laser and IPL technology in dermatology and aesthetic medicine. Springer-Verlag Berlin Heidelberg; 2011:2-22.
19. Sabaa HS, Zghair KH, Mohammed NR, Musa IS, Abd RS. The effect of Nd:YAG lasers on leishmania donovani promastigotes. *World J Exp Biosci*. 2016;**4**:25-8.
20. Omidian M, Jadbabaei M, Omidian E, Omidian Z. The effect of Nd:YAG laser therapy on cutaneous leishmaniasis compared to intralesional meglumine antimoniate. *Postepy Dermatol Alergol*. 2019;**36(2)**:227–31.
21. Yanik M, Gurel MS, Simsek Z, Kati M. The psychological impact of cutaneous leishmaniasis. *Clin Exp Dermatol*. 2004;**29(5)**:464-7.
22. Asilian A, Sadeghinia A, Faghihi G, Momeni A. Comparative study of the efficacy of combined cryotherapy and intralesional meglumine antimoniate (Glucantime®) vs. cryotherapy and intralesional meglumine antimoniate (Glucantime®) alone for the treatment of cutaneous leishmaniasis. *Int J Dermatol*. 2004;**43(4)**:281-3.
23. Salmanpour R, Razmavar MR, Abtahi N. Comparison of intralesional meglumine antimoniate, cryotherapy and their combination in the treatment of cutaneous leishmaniasis. *Int J Dermatol*. 2006;**45(9)**:1115-6.
24. Al-Sabak H, Al-Dhalimi MA, Ali WA. Treatment of verruca vulgaris with long pulsed Nd:YAG laser 1064 nm in Iraqi patients. *Kufa J Nurs Sci*. 2019;**9(1)**:1-10.
25. El-Sayed M, Anwar AE. Intralesional sodium stibogluconate alone or its combination with either intramuscular sodium stibogluconate or oral ketoconazole in the treatment of localized cutaneous leishmaniasis: a comparative study. *J Eur Acad Dermatol Venereol*. 2010;**24(3)**:335-40.
26. Sharquie KE, Al-Talib KK, Chu AC. Intralesional therapy of cutaneous leishmaniasis with sodium stibogluconate antimony. *Br J Dermatol*. 1988;**119(1)**:53-7.
27. Ghos S. Evaluation of sodium stibogluconate in treatment of cutaneous leishmaniasis. *Curr Med Res Opin*. 1978;**6**:280-3.
28. Faris RM, Jarallah JS, Khoja TA, al-Yamani MJ. Intralesional treatment of cutaneous leishmaniasis with sodium stibogluconate antimony. *Int J Dermatol*. 1993;**32**:610-12.
29. Arshad AR, Arshad A. Intralesional ciprofloxacin for cutaneous leishmaniasis: Comparison with meglumine antimoniate. *Pak J Med Sci*. 2011;**27(3)**:566-8.