

Successful treatment of diabetic foot ulcers with low-level laser therapy

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Abstract

Introduction: Diabetic foot ulcers, being notoriously difficult to cure, are one of the most common health problems in diabetic patients.

There are several surgical and medical options already introduced for treatment of diabetic foot ulcers.

Low-level laser therapy (LLLT) has been suggested as a promising treatment option for open wounds. However, there is very little work on the efficacy of low-level laser therapy for this type of open wounds.

We report herein seven cases of grades II and III diabetic foot ulcer completely treated with LLLT.

Materials and methods: Seven Type 2 diabetic patients (four males: mean age, 63 years; three females: mean age, 61.14 years) with grades II and III diabetic foot ulcers were treated with low-level laser therapy. The mean duration of diabetes was 10.5 years and the ulcers were present from average 6.5 months ago. The mean value for glycosylated hemoglobin (HbA1C) also was 8.14 mg/dl (range: 6–12.2) and foot blood flow in Doppler ultra-sonography were normal.

We used low-level laser therapy through local irradiation of the ulcer bed with red light (660 nm; power: 25 MW; 0.6–1 J/cm²) and ulcer margins with infrared laser (980 nm; power: 200 MW; 4–6 J/cm²), along with intravenous laser irradiation with red light laser (650 nm; power: 1.5 MW) for 15–20 min, in addition to laser acupuncture with infrared laser (1 J/cm²) for LI-11, LI-6, SP-6, PC-6, ST-36 and GB-34 points.

Sessions were every other day for 10–15 sessions (Route 1) and then continuing the course twice weekly (Route 2) until complete recovery was achieved.

Results: After approximately 19 sessions (mean Route 1 sessions ≈15; mean Route 2 sessions ≈10), complete recovery was achieved in all cases and there was no relapse or other problem with ulcers after approximately 6 months (range: 2–10 months) of follow-up. With this treatment regimen, there were no side-effects reported by the patients.

Conclusion: Low-level laser therapy could be a safe and effective method for treatment of diabetic foot ulcers. Clinical trials with higher sample size are proposed to more evaluate the efficacy of low-level laser therapy in treatment of this type of wounds.

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Keywords: Low-level laser therapy; Diabetic foot ulcer; Laser acupuncture; Grades II and III ulcers

1. Introduction

Diabetic foot ulcers, being notoriously difficult to treat, are one of the most common health problems in diabetic patients.

These ulcers due primarily to disturbed microcirculation cause considerable morbidity and expense. Their significance for the individual, as well as for society, is evident [1–4].

There are several surgical and medical conservative therapeutic options already available for treatment of diabetic foot ulcers [5].

During past 30 years, low-level lasers have been widely used in medical fields. Recently, there has been an increase

in the clinical applications of low-level laser irradiation in various therapeutic fields. One of the most important functional aspects of laser therapy is photobiostimulatory effects of low-level lasers on various biological systems especially microcirculation; this is based on the effects of low intensity lasers, often described as lasers with less than 500 MW average power [6–10].

Low-level laser therapy (LLLT) has been suggested as a promising treatment option for open wounds. However, very little is reported on the efficacy of low-level laser therapy for diabetic wounds.

We report herein seven cases of grades II and III diabetic foot ulcers completely healed by LLLT as an alternative therapeutic method to routine medical conservative treatment.

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2. Materials and methods

Seven Type 2 diabetic patients (four males: mean age, 63 years; three females: mean age, 61.14 years, S.D.: 12.13) with grades II and III diabetic foot ulcers according to Braden Scale [11], refractory to conventional treatments were treated with low-level laser therapy. The mean duration of diabetes was 10.5 years and the ulcers were present from an average of 6.5 months. The mean value for glycosylated hemoglobin (HbA1C) also was 8.14 mg/dl (S.D.: 1.93, range: 6–12.2) and foot blood flow in Doppler ultra-sonography were normal.

The patients' characteristics are shown in detail in Table 1, and the overall data are reported in Table 2.

We used low-level laser therapy through local irradiation of ulcer bed with red light (660 nm; power: 25 MW; 0.6–1 J/cm², Mustang 2000, Moscow, Russia) and ulcer margins with infrared laser (980 nm; power: 200 MW; 4–6 J/cm², Mustang 2000, Moscow, Russia), along with intravenous red light laser (655 nm, 2 MW for 20 min) (a fibre optic laser conduit inserted via a needle placed on forearm in median cubital vein) and laser acupuncture with infrared diode laser (1 J/cm²) for LI-11, LI-4, SP-6, PC-6, ST-36 and GB-34 points every other day. Sessions were every other day for 10–15 sessions (Route 1) and then continuing the course twice weekly (Route 2) until complete recovery achieved.

3. Results

During an average of about 19 sessions (mean Route 1 sessions ≈15; mean Route 2 sessions ≈10) of low-level laser irradiation, complete recovery (Fig. 1) achieved in all cases and there was no relapse or other problem with ulcers during average of about 6 months (range: 2–10 months, S.D.: 2.67) of follow-up.

Except for one of cases that, because of very extensive ulcer area and low responsiveness, took a total of 26 sessions of Route 1 low-level laser irradiation, the rest of patients received up to 15 sessions of the profile.

With this treatment regimen, there were no side-effects reported by the patients in this period.

4. Discussion

Diabetic foot problem due primarily to neuropathy and resulting microcirculatory damage imposes considerable morbidity and costs to the individuals as well as for societies [1–4].

The exact pathophysiological mechanisms for this condition have not yet been elucidated. However, increased capillary permeability and decreased reactivity of arteriols to various stimuli are already proposed [12–15].

Early research suggests that laser therapy may have a role in hastening wound healing. Attempts have been made to use

Table 1
Patients primary data enrolled to the study

Patient no.	Gender	Age (year)	Duration of diabetes (year)	History of diabetic ulcer	History of previous amputation	HbA1C (mg/dl)	FBS (mg/dl)	BMI (kg/m ²)	HWR	TG (mg/dl)	LDL/HDL ratio	Total ulcer area (mm ²)	Maximum depth of the ulcer (mm)
1	Female	64	10	No	No	7.70	165	25.16	1.13	190	2.48	60	0
2	Male	57	10	No	No	7.80	101	30.56	1.03	160	4.41	50	3
3	Male	44	1.5	Yes	Yes	6.00	68	29.76	1.10	117	1.19	200	5
4	Male	75	12	No	No	7.18	148	26.03	1.13	159	5.29	300	3
5	Female	49	15	No	No	12.20	151	30.97	1.09	120	1.81	2400	2
6	Female	63	15	No	No	8.00	209	31.60	0.94	124	2.17	274	3
7	Male	76	12	No	No	8.10	165	27.43	1.03	170	2.13	49	0

Patient no.	Ulcer duration (months)	Insulin use	AB use	Route 1 sessions	Route 2 sessions	Follow-up period (months)
1	6	Yes	Yes	15	0	7
2	6	No	No	15	0	4
3	8	No	Yes	12	12	Continued
4	8	Yes	Yes	12	10	8
5	7	Yes	Yes	26	6	10
6	6	No	Yes	10	0	5
7	7	yes	No	12	0	2

HbA1C: glycosylated hemoglobin, FBS: fasting blood sugar, BMI: body mass index, HWR: hip-to-waist ratio, TG: triglyceride, LDL: low-density lipoprotein, HDL: high-density lipoprotein, AB: antibiotics.

Table 2
Patients overall data

	Number	Minimum	Maximum	Mean	S.D.
Age	7	44	76	61.14	12.130
Diabetes duration	7	1.50	15.00	10.7857	4.58128
HbA1C	7	6.00	12.20	8.1400	1.92852
FBS	7	68	209	143.86	46.182
BMI	7	25.16	31.60	28.7871	2.56146
HWR	7	0.94	1.13	1.0643	0.06876
TG	7	117	190	148.57	28.378
LDL/HDL	7	1.19	5.29	2.7829	1.48944
Ulcer area	7	49	2400	476.14	855.043
Ulcer duration	7	6.0	8.0	6.857	0.8997
Max ulcer height	7	0.0	5.0	2.286	1.7995
Route 1 sessions	7	10	26	14.57	5.350
Route 2 sessions	7	0	12	4.00	5.292
Follow-up period	7	2	10	6.14	2.673

HbA1C: glycosylated hemoglobin, FBS: fasting blood sugar, BMI: body mass index, HWR: hip-to-waist ratio, TG: triglyceride, LDL: low-density lipoprotein, HDL: high-density lipoprotein, LDL/HDL: LDL-to-HDL ratio.

helium neon, CO₂, and KTP lasers in encouraging wound healing in diabetics [16].

In spite of the extensive work for effectiveness of low-level laser therapy in wound healing process, very little work already exists for application of this complementary therapeutic method for diabetic ulcers, especially in diabetic foot patients.

Schindl et al. reported the first case of diabetic foot patient treated with low-intensity laser therapy in 1999 and proposed that this therapeutic method might constitute a useful side-effect-free alternative treatment modality for the induction of wound healing of neuropathic ulcers in diabetic patients [17].

Since then, some researches have been oriented to application of low-intensity lasers for treatment of diabetic foot ulcers. But contradictory results have been achieved through different research plans.

Cullum et al. in a systemic review concluded that there is generally insufficient reliable evidence to draw conclusions about the contribution of laser therapy to chronic wound healing [18].

ATPase activity changes, long-term erythrocytes membrane proteins as well as lipid bilayer structural changes, and resulting change in membrane ion pumps activities [19], res-

piratory burst of neutrophils through activation of Protein tyrosine kinase and phospholipase C [20], dose-dependent priming of polymorphonuclear leukocytes [21] have all been mentioned concerning cellular mechanism of action of low intensity laser irradiation.

A previous study of laser biostimulation on wound healing in diabetic mice suggests that such therapy may be of great benefit in the treatment of chronic wounds that occur as a complication of diabetes mellitus [22].

Also, improvement of skin circulation in patients with diabetic microangiopathy has been reported [23] and low-level laser irradiation has been shown to accelerate collateral circulation, enhance microcirculation [24] as well as relaxation of vascular smooth muscle [25].

Our work although was not a mono-laser method, and composed three separate lasers, including laser acupuncture, but cure of all diabetic feet in about 1.5–2 months gives us hopes for opening new horizons in treatment of diabetic foot ulcers as already known to be refractory chronic ulcers.

However, more clinical and experimental studies are proposed to be needed to describe a distinct laser profile for treatment of diabetic foot ulcers in suffering patients.

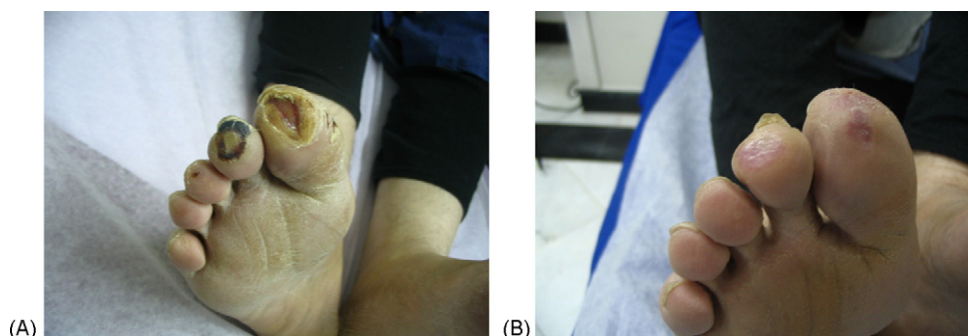


Fig. 1. A diabetic foot ulcer; beginning of low-level laser therapy (A), and in the end of treatment period (B).

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