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# Managing Pain with Laser Acupuncture

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Additional information is available at the end of the chapter

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## Abstract

According to the theory of traditional Chinese medicine, Qi flows through the body along specific paths known as meridians. Any disturbance in Qi evokes a Ying–Yang imbalance in the body, and consequently leads to disease. Pain results from blood stasis and Qi stagnation. Laser acupuncture (LA), first introduced clinically in the 1970s, combines the advantages of traditional acupuncture and modern laser medicine and has been applied for the treatment of various diseases. Here, we investigated studies on the use of LA for pain management according to current evidence. Articles including English keywords related to the use of LA for pain, published between January 2006 and August 2015 were sourced from PubMed, Medline, and Cochrane Library databases. On the basis of these papers, we explored the modern applications, mechanisms, and analgesic effects of LA. LA integrates the positive effects of acupuncture and low-level laser therapy, and is therefore effective in activating blood and in moving Qi. LA relieves pain through both anti-inflammatory and analgesic effects. No adverse effects or complications resulting from LA were reported in the literature. In the hands of an experienced physician, LA can be a useful and safe method for pain management.

**Keywords:** laser acupuncture, low-level laser therapy, acupuncture, pain, traditional Chinese medicine

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## 1. Introduction

Although written accounts of acupuncture date back over 2000 years, archaeological evidence suggests more than 3000 years of practice. According to the principles of traditional Chinese medicine (TCM), energy (or Qi) flows through the body along specific paths known as meridians. Balanced Qi contributes to the maintenance of good health. On the other hand, any

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disturbance in Qi results in an energy imbalance in the body. This imbalance, either an excess or a deficiency, may then result in disease [1]. Both blood stasis and Qi stagnation will lead to pain [2]. In 1996, the World Health Organization (WHO) confirmed 64 indications for acupuncture treatment. Acupuncture treats the underlying diseases by stimulating specific acupuncture points along the meridians. Acupuncture is one of the most common types of alternative treatments for patients who suffer from long-term pain. Moreover, it is a relatively safe procedure with minimal adverse effects [3]. Even though acupuncture has been proven to be effective for many therapeutic applications, metal needling is not widely accepted owing to fear of possible contamination or transcutaneous lesions [4]. Consequently, following the theory of TCM, the use of low-level laser on acupuncture points has been developed as a new therapeutic approach called laser acupuncture (LA) [5, 6].

LA was first introduced clinically in the 1970s [7]. It has been widely studied over several years to turn it into an evidence-based clinical practice. The use of low-intensity and nonthermal laser irradiation stimulation of acupuncture points is an effective alternative to traditional metal needling; it is a safe technique because it is noninvasive and is acceptable to needle-phobic persons. Thus, LA can be used at acupuncture points that require complicated applications of needles [1, 8]. The laser beam is an electromagnetic wave and can stimulate acupuncture points in the human body by depositing energy without causing heating. In contrast to needling, acupuncture points irradiated by a laser beam need to receive sufficient energy to induce a physiological effect at the cellular level based on the principle of “photobiomodulation.” The beam excites the relevant channels and activities, regulates the function of organs, and promotes metabolism. Recently, several papers have reported that the decisive factor in the efficacy of LA is the applied dosage [5, 9–11].

Although the mechanisms underlying LA are not well understood, LA is widely applied clinically. LA is also referred to as low-level laser therapy (LLLT), with 0.1–0.5 J/cm<sup>2</sup> deposited per acupuncture point, or 1–4 J/cm<sup>2</sup> per Ashi point [12]. LLLT has an anti-inflammatory function because it can reduce the levels of certain biochemical factors (prostaglandin E<sub>2</sub>, messenger ribonucleic acid cyclooxygenase-2, interleukin (IL)-1 $\beta$ , and tumor necrosis factor (TNF)- $\alpha$ ), neutrophil influx, oxidative stress, edema, and hemorrhaging [13]. Analgesia induced by laser phototherapy is mediated by peripheral opioid receptors [14]. Nevertheless, LA has both local and distant analgesic effects, which may be mediated by different mechanisms. LA combines the advantages of traditional metal-needle acupuncture and LLLT. This chapter on managing pain by LA focuses on how LA may be an alternative method of relieving pain and improving functional outcomes.

## 2. Review of the clinical literature

Clinical literature in electronic databases—PubMed, Medline, and Cochrane library—was surveyed using the terms “laser acupuncture”, “low level laser therapy”, and “pain”, published from January 2006 to August 2015. All papers had to meet the following criteria: randomized controlled trials (RCTs) that considered a control group (either placebo, sham LA,

nonstandard traditional acupuncture, or other therapeutic equipment) and retrospective/prospective clinical studies in which LA/LLLT was used. Studies cited in review articles were also included. Papers published in languages other than English were excluded. Conference abstracts, single-case studies, and paper for which full text was not available were also excluded.

Among the reviewed literature, most studies targeted myofascial pain, fibromyalgia, tendinopathy, radiculopathy, osteoarthritis (OA), low back pain, temporomandibular joint dysfunction (TMD), and headache. These are discussed below.

### **2.1. Myofascial pain**

Kiralp et al. [15] reported a RCT in which 43 patients with myofascial pain were enrolled, and showed the positive effect of LA as compared to prilocaine injection. Eight other RCTs also showed the pain-relieving effect of LA; some of these focused on myofascial pain over the cervical region [16, 17], masseter [18], masticatory muscles [19, 20], trapezius [21, 22], or trigger points [23]. The consistency of these trials highlighted the efficacy of LA in the treatment of myofascial pain.

### **2.2. Fibromyalgia**

Two RCTs showed different results for LA treatment of fibromyalgia [24, 25]. Both of these studies obtained subjective pain presentation using a visual analog scale (VAS), the Fibromyalgia Impact Questionnaire (FIQ), and other measures. Armagan et al. [24] reported positive results of LA for treating the pain of fibromyalgia. The difference between these studies was the dose and power density. Armagan et al. set the parameters of LA to 830 nm, 2 J/point, and 50 mW. These results suggested that the treatment effect of LA was inconclusive in fibromyalgia or that the power density used should be sufficiently high to manage the pain in this disease group.

### **2.3. Tendinopathy**

Two RCTs showed positive results of LA in pain management of lateral epicondylitis (LE) [26, 27], also known as tennis elbow. Emanet et al. [27] reported that even though LA had no short-term advantage over the placebo in patients with LE, there was a significant long-term improvement, especially in functional parameters. Another RCT reported that LA had a treatment effect equal to that of ultrasound [28]. Moreover, a systemic review revealed that applying LLLT to myofascial trigger points of LE patients was an effective treatment for pain reduction and also led to increase in grip force, range of motion (ROM), and weight test [9]. As for tendomyopathy of the masticatory musculature, the pilot study showed inconclusive results because there were few participants [19].

### **2.4. Radiculopathy**

Konstantinovic et al. [29] performed an RCT that enrolled 60 patients with acute neck pain with cervical radiculopathy. After a 3-week LA treatment, VAS, neck movement, neck

disability index, and quality of life indicated the positive effect of LA. Radiculopathy of other spinal segments was not reported.

## 2.5. Osteoarthritis

Among the four RCTs on the use of LA in treating the pain of knee OA, two showed a positive result [30, 31], one was inconclusive [32], and the other one reported efficacy after 2 weeks of treatment but not at the 4-week assessment [33]. However, the RCT showed the inconclusive result for only one point, ST35. An inappropriate dose or insufficient irradiation at a point may be the reason for the poor treatment effect.

## 2.6. Low back pain

Glazov et al. [34] had reported negative result for the use of LA to relieve low back pain in their study, in which LA was applied to local points of three meridians (Bladder, Gallbladder, and Governor vessel) and Ashi points. Subsequently, Glazov [35] reported another RCT, in which 100 patients with low back pain were enrolled, and found a positive result for pain management with LA. However, the parameter settings used for the second RCT were not described. Therefore, we were not able to determine the differences that contributed to the successful treatment. Nevertheless, further two RCTs showed a positive response for low back pain treated with LA [36, 37].

## 2.7 Temporomandibular joint disorder

In our literature search, all four RCTs suggested a positive treatment effect for LA in treating the pain associated with TMD [4, 38–40]. Occlusal splinting is the nonsurgical standard treatment for this condition in dental clinics. In two RCTs, LA was found to be as effective as occlusal splinting in relieving TMD-associated pain [39, 40]. LA could be an alternative treatment choice to occlusal splinting. Sattayut and Bradley [41] compared low- and high-grade LA and found that high-grade LA, i.e., 820 nm, 107 J/cm<sup>2</sup>, and 300 mW, showed a superior treatment effect. More recently, Hu et al. [42] clearly showed the therapeutic effects of LA in managing treatment-resistant TMD. In our literature review, another two clinical trials revealed the benefit of LA therapy for TMD patients [43, 44].

## 2.8. Headache

Gottschling et al. [45] reported an RCT in which LA was used to treat headache in children and showed a decrease in the VAS score and monthly hours with headache. Interestingly, the treatment in this study consisted of only four treatment episodes, at a frequency of once a week, yet the improvement of symptoms was excellent. This study also focused on the meridian-based selection of irradiation points. The basic points for patients with frontal headache were LI4 and ST36; for lateral pain, they were TE6 and GB34; for occipital pain, they were SI3 and BL60, and for holocephalic pain, it was GV20. Additional body acupuncture points and ear acupuncture points were chosen individually. The combination of TCM meridian theory with

LA energy treatment seemed to provide a better effect than simply irradiating the tender points.

### 2.9. Others

Chow et al. [17] reported that chronic neck pain of any etiology could be treated successfully with a program of 14 LA treatments over a period of 7 weeks. Ip and Fu [46] reported a prospective cohort study that proved the treatment efficacy of LA in painful adhesive capsulitis of the shoulder.

### 3. Conclusions

We have presented evidence supporting the use of LA in the management for various types of pain (Table 1). LA is a noninvasive technique involving the stimulation of traditional acupuncture points with low-intensity laser irradiation. LA has the advantages of being painless and safe as no heat is generated during the procedure, and it is more effective in some medical conditions and requires less time than needle-based acupuncture [47]. No adverse effects or complications resulting from LA have been reported in any study to date. The effectiveness of LA in managing pain depends on the selection of appropriate points and frequencies. Insufficient energy and very few therapeutic sessions will result in ineffective therapy. In conclusion, LA combines the positive effects of traditional Chinese acupuncture and LLLT, and is therefore effective in both activating blood and moving Qi. LA relieves pain through both anti-inflammatory and analgesic effects. As experienced physicians, we should optimize laser parameters, treatment intervals, and long-term follow-up for LA therapy.

Study	Study design	Subjects	Diagnosis	Control	Intervention time	Wavelength	Dose	Power	Irradiation time (s)	Acupoints	Outcome measure	Results
Kiralp et al. [15]	RCT	43	Myofascial pain syndrome	Prilocaine injection	4 weeks (12 sessions)	—	—	—	180	Trigger points in the neck, shoulder, and back muscles	VAS, VPS, pressure pain threshold by pressure algometer	Positive in pressure algometer
Chow et al. [17]	RCT	90	Chronic neck pain	Placebo	7 weeks (14 sessions)	830 nm	0.67 W/cm <sup>2</sup>	300 mW	30	Tender points	VAS	Positive
Armagan et al. [24]	RCT	32	Fibromyalgia	Placebo	2 weeks (10 sessions)	830 nm	2 J/point	50 mW	60	Tender points	NTP, FIQ, morning stiffness, VSGI, and total myalgia score	Positive
Yurtkuran et al. [30]	RCT	52	Knee OA	Placebo	2 weeks (10 sessions)	904 nm	0.48 J	10 mW	120	SP9	VAS, 50-foot walking time, KC, MTS, WOMAC, NHP	Improvement in KC
Mazetto et al. [38]	RCT	48	TMD	Placebo	4 weeks (8 sessions)	708 nm	89.7 J/cm <sup>2</sup>	70 mW	10	One point inside the external auditory duct	VAS	Positive
Matsutani et al. [25]	RCT	20	Fibromyalgia	Stretching plus LLLT versus no laser	End of intervention	830 nm	3 J/cm <sup>2</sup>	30 mW	—	—	VAS, dolorimetry at tender points, FIQ, SF-36	Negative
Lam and Cheing [26]	RCT	39	Lateral epicondylitis	Placebo	3 weeks (9 sessions)	904 nm	2.4 J/cm <sup>2</sup>	25 mW	11	Tender points	VAS, DASH questionnaire	Positive
Dundar et al. [16]	RCT	64	Cervical Myofascial pain	Placebo	3 weeks (15 sessions)	830 nm	7 J/point	58 mW	120	Trigger points	VAS, ROM,	Positive

Study	Study design	Subjects	Diagnosis	Control	Intervention time	Wavelength	Dose	Power	Irradiation time (s)	Acupoints	Outcome measure	Results
Shen et al. [31]	RCT	48	Knee OA	Combined laser versus red light	3 times/week for 2 weeks then 2 times/week for 4 weeks	650 nm semiconductor laser plus 10.6 $\mu\text{m}$ CO <sub>2</sub> laser	—	—	—	ST35	WOMAC	neck disability index Positive but in-conclusive difference
Gottschling et al. [45]	RCT	43	Headache in children	Placebo	4 weeks (4 sessions)	830 nm	0.9 J/cm <sup>2</sup>	30 mW	30	LI4, ST36; TE6, GB34; SI3, BL60; GV20	VAS; monthly hours with headache	Positive
Shirani et al. [20]	RCT	16	Myofascial pain of masticatory system	Placebo	3 weeks (6 sessions)	660 nm; 890 nm	6.2 J/cm <sup>2</sup> ; 117.3 mW; J/cm <sup>2</sup>	9.8 W	180; 600	Tender points	VAS	Positive
Shen et al. [32]	RCT	40	Knee OA	Placebo	4 weeks (12 sessions)	650 nm semiconductor laser plus 10.6 $\mu\text{m}$ CO <sub>2</sub> laser	—	36 mW; 200 mW	1200	ST35	WOMAC	In-conclusive
Glazov et al. [34]	RCT	100	Chronic non-specific low back pain	Placebo	5–10 sessions	830 nm	0.2 J/point	10 mW	20	Points on BL, GB, GV meridians; Ashi points	VAS; ODI; DASS-21; PWI-A	Negative
Carrasco et al. [23]	RCT	60	Myofascial pain	Placebo	4 weeks (8 sessions)	780 nm	25, 60 and 105 J/cm <sup>2</sup>	—	—	Trigger point	—	Positive
Zhao et al. [33]	RCT	40	Knee OA	Non-acupoint sham control	4 weeks (12 sessions)	650 nm semiconductor laser plus 10.6 $\mu\text{m}$ CO <sub>2</sub> laser	650 nm laser energy of 43.2 J; 10.6 $\mu\text{m}$ laser energy of 120 J	36 mW; 200 mW	1200	ST35	WOMAC	Positive after 2 weeks treatment, but not at 4 weeks
Öz et al. [39]	RCT	40	Myofascial pain due to TMD	occlusal splint	5 weeks (10 sessions)	820 nm	3 J/cm <sup>2</sup>	300 mW	—	—	VAS	As effective
Katsoulis et al. [19]	Pilot study	11	Tendomyopathy of masticatory musculature	Placebo	3 weeks (6 sessions)	690 nm	40–60 J	40 mW	900	ST6, SI18, SI3, LI4	VAS	In-conclusive
Glazov [35]	RCT	100	Low back pain	Placebo	5–10 sessions	—	—	—	—	—	VAS	Positive
Hotta et al. [43]	Clinical trial	10	TMD	No treatment	10 weeks (10 sessions)	780 nm	35 J/cm <sup>2</sup>	70 mW	20	LI4, HT3, ST6, ST7	EMG, VAS	Positive
Konstantinovic et al. [29]	RCT	60	Acute neck pain with cervical radiculopathy	Placebo	3 weeks (15 sessions)	905 nm	2 J/cm <sup>2</sup>	12 mW/cm <sup>2</sup>	120	Lateral to spinous process and the neck disability two next spinal index, quality of segment life	VAS, neck movement, quality of life	Positive
Lee and Han [21]	RCT	24	Myofascial trigger point pain	Placebo	End of intervention	830 nm	386, 771, 1929 J/cm <sup>2</sup>	450 mW	1, 2, 5 min	Trigger points	PPT	Positive in 5 min
Emanet et al. [27]	RCT	50	Lateral epicondylitis	Placebo	3 weeks (15 sessions)	905 nm	1 J/cm <sup>2</sup>	—	120	Two most sensitive points around the lateral epicondyle	VAS, tenderness, DASH questionnaire, PRTEE test, pain-free grip strength, NHP questionnaire	Positive in long-term evaluation (12 weeks)
Skorupska et al. [28]	RCT	80	Tennis elbow	Ultrasound	10 days with a weekend break (10 sessions)	820 $\pm$ 10 nm	1; 5 J/cm <sup>2</sup>	400 mW	—	Trigger points	Algometer, VAS, DASH questionnaire, and hand grip strength	Equally effective
Kannan [22]	RCT	45	Myofascial pain of upper trapezius	ultrasound; ischemic compression	5 days (5 sessions)	904 nm	74 mJ/cm <sup>2</sup>	—	30	Trigger points	VAS, provocative pain test, active lateral bending of the cervical spine	Positive
Sattayut and Bradley [41]	RCT	30	Temporomandibular joint disorder	Low-energy-density laser versus high-energy versus placebo	1 week (3 sessions)	820 nm	21.4, 107 J/cm <sup>2</sup>	60 mW; 300 mW	—	3 points around TMJ; 3 most tender trigger points	PPT, MOSP, SSI, EMG	Positive in higher energy group
Lin et al. [36]	RCT	60	Low back pain	Placebo	5 days (5 sessions)	808 nm	15 J/cm <sup>2</sup>	40 mW	600	BL40; Ashi acupoints	VAS, Ryodoraku	Positive
Ferreira et al. [4]	RCT	40	TMD	Placebo	3 months (12 sessions)	780 nm	112.5 J/cm <sup>2</sup>	50 mW	90	ST6, SI19, GB20, GB43, LI4, LR3, NT3, EX-HN3	VAS	Positive
Uemoto et al. [18]	RCT	21	Myofascial pain syndrome of masseter muscle	Anesthetic injection,	8 days (4 sessions)	795 nm	Right: 4 J/cm <sup>2</sup> ; Left: 8 J/cm <sup>2</sup>	80 mW	—	Trigger points	Surface EMG, mouth opening, VAS	Positive

Study	Study design	Subjects	Diagnosis	Control	Intervention time	Wavelength	Dose	Power	Irradiation time (s)	Acupoints	Outcome measure	Results
Huang et al. [44]	Clinical trial	20	TMD	dry needling, placebo	Once a week till symptom relief or 3 weeks of no improvement	800 nm	100.5 J/cm <sup>2</sup>	0.75 W/cm <sup>2</sup>	134	ST6, ST7, LI4 and one local Ashi point	VAS	Positive
Demirkol et al. [40]	RCT	30	Myofascial pain due to TMD	occlusal splint; placebo	10 days (10 sessions)	1064 nm	8 J/cm <sup>2</sup>	250 mW	20	Trigger points	VAS	As effective as occlusal splint
Hu et al. [42]	Clinical trial	29	Treatment-resistant TMD	—	4 weeks (12 sessions)	810 nm	7.5–26.25 J/cm <sup>2</sup>	5 W/cm <sup>2</sup>	5 sec (acupoint); 40 sec (Ashi point)	ST7, ST6, LI4 and Ashi point	VAS, MMO	Positive
Shin et al. [37]	RCT	56	Low back pain	Sham laser	1 week (3 sessions)	660 nm	—	50 mW	180	GV3, GV4, GV5, BL23, BL24, BL25, BL40, GB30	VAS, PPT, PGIC, EQ-5D	Positive
Ip and Fu [46]	Prospective cohort study	50	Painful adhesive capsulitis of shoulder	—	8 week (24 sessions)	810 nm	5.4 J/point	20 mW/cm <sup>2</sup>	20–30	6 anatomic points; SI11, SI12	Constant Murley shoulder score	Positive

DASH: disabilities of the arm, shoulder, and hand; DASS-21: Depression Anxiety Stress Scale; EMG: electromyography; EQ-5D: Euro-Quality-of-Life Five Dimensions questionnaire; KC: knee circumference; MOSP: maximum mouth opening (MMO) without pain; MTS: medial tenderness score; NHP: Nottingham Health Profile; NTP: number of tender points; ODI: Oswestry Disability Index; PGIC: Patient Global Impression of Change; PPT: pressure pain threshold; PRTEE: Patient-Related Lateral Epicondylitis Evaluation; PWI-A: Personal Wellbeing Index; SF-36: 36-item Short-Form Health Survey; VPS: verbal pain scale; VSGI: global improvement on a verbal scale; WOMAC: Western Ontario and McMaster Universities osteoarthritis index.

**Table 1.** Summary of clinical studies into pain management with laser acupuncture.

## Abbreviations

**DASH** disabilities of the arm, shoulder and hand

**DASS-21** Depression Anxiety Stress Scale

**EMG** electromyography

**EQ-5D** Euro-Quality-of-Life Five Dimensions questionnaire

**FIQ** Fibromyalgia Impact Questionnaire

**FIQ** Fibromyalgia Impact Questionnaire

**KC** knee circumference

**LA** laser acupuncture

**LE** lateral epicondylitis

**LLLT** low-level laser therapy

**MOSP** maximum mouth opening (MMO) without pain

**MTS** medial tenderness score

**NHP** Nottingham Health Profile

- NTP** number of tender points
- OA** osteoarthritis
- ODI** Oswestry Disability Index
- PGIC** Patient Global Impression of Change
- PPT** pressure pain threshold
- PRTEE** Patient-Related Lateral Epicondylitis Evaluation
- PWI-A** Personal Wellbeing Index
- RCT** randomized controlled trial
- ROM** active range of motion
- SF-36** 36-item Short-Form Health Survey
- SSI** symptom severity index
- TCM** traditional Chinese medicine
- TMD** temporomandibular joint (TMJ) disorder
- VAS** visual analogue scale
- VPS** verbal pain scale
- VSGI** global improvement on a verbal scale
- WHO** World Health Organization
- WOMAC** Western Ontario and McMaster Universities osteoarthritis index

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