
Explore Laser Acupuncture's Role

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1. Introduction

Acupuncture has been widely used in the treatment of many diseases for over 2000 years. It is traditionally performed by inserting thin needles into acupuncture points in human body; this is known to affect the functions of various organs. According to the theory of traditional Chinese medicine, energy (or Qi) flows through the body along specific paths known as meridians. Any disturbance in this Qi results in an energy imbalance in the body; this imbalance may in turn result in disease. Acupuncture attempts to regulate and restore energy balance by stimulating specific acupoints along the meridians and thereby treat the underlying disease. In 1979, the World Health Organization (WHO) identified 43 conditions that might benefit from acupuncture. In 1996, WHO confirmed 64 indications for acupuncture treatment.

Recently, laser acupuncture (LA) has been used as a complementary and alternative therapy in addition to traditional acupuncture. It was first introduced clinically in the 1970s [1, 2]. LA is defined as the stimulation of traditional acupuncture points with low-intensity, non-thermal laser irradiation [3]. A laser beam is an electromagnetic wave and can stimulate the acupuncture points in the human body by depositing energy without heating. In doing so, the beam excites the channels and properties, regulates the function of organs, and promotes metabolism. It can function as both acupuncture and moxibustion via different frequencies, e.g., the information of the needle type (steel, gold/silver, left/right turn etc.). According to the research of Manfred Reininger et al, frequencies (Reininger frequencies: LU= 824 Hz, LI= 553 Hz, ST= 471 Hz, SP= 702 Hz, HT= 497 Hz, SI= 791 Hz, BL= 667 Hz, PC= 530 Hz, TE= 732 Hz, GB= 583, LR= 442 Hz; Bahr frequencies: B1= 599.5 Hz, B2= 1199 Hz, B3= 2388 Hz, B4= 4776 Hz, B5= 9552 Hz, B6= 19104 Hz, B7= 38208 Hz; Nogier frequencies: A'= 292 Hz, B'= 584 Hz, C'= 1168 Hz, D'= 2336 Hz, E'= 4672 Hz, F'= 9344 Hz, G'= 18688 Hz) can be applied to acupuncture points to improve the meridian energy. In this chapter, we explore laser acupuncture's role in modern medicine with a focus on how it strengthens and promotes the current methods of treatment.

2. Laser acupuncture vs. acupuncture

Instead of using a metal acupuncture needle, LA uses red or near-infrared light with a wavelength between 600 and 1000 nm and power between 5 and 500 mW. It is also referred to as low level laser therapy (LLLT), with 0.1–0.5 J/cm² being deposited per acupoint, or 1–4 J/cm² per Ashi point. Because of the low absorption of laser light by human skin in the given wavelength range, it has been hypothesized that laser light can penetrate deeply into the tissue, where it may have a photobiostimulation effect [4].

LA combines the advantages of traditional Chinese acupuncture and modern laser medicine. However, in some ways, laser energy may be more suitable than the traditional needle for stimulating the oscillating energy field of the meridian system. The correct frequency modulation of the monochromatic laser beam energizes the meridian and acupuncture point and thereby improves the oscillation of the meridian's own frequency. In addition, some patients may avoid acupuncture because of fear of pain and LA may be less invasive, less painful, and safer than traditional acupuncture. It may also be an improvement over traditional moxibustion, because it uses similar energy levels but avoids harmful effects related to smoke and heat (Table 1).

3. Review of the clinical literature

3.1. Pain

Assessment of the methods and findings of clinical trials on LA is confounded by the lack of detail in some studies in the literature. It is also noteworthy that all studies reporting negative results (no significant benefit of LA compared with control or sham conditions) lacked details regarding treatment parameters, such as laser power or dose [5].

Treatment	Instrument	Invasiveness	Sensations	Pain
Traditional acupuncture	Needle	Invasive	Soreness, numbness, expansion, or pain	Painful
Laser acupuncture	Low-level laser	Non-invasive	None or slight warmth (if > 10 J/cm ²)	Painless

Table 1. Comparison of traditional and laser acupuncture

3.1.1. *Low back pain*

Glazov used multiple regression analysis to identify which baseline characteristics predicted pain changes in the immediate, short, and intermediate terms. They found that higher pain scores at baseline predicted greater pain relief after LA for chronic non-specific low back pain. Adjusted analysis suggested a clinically significant effect on pain with LA compared to sham treatment ($P < 0.05$), at short term follow-up only [6]. Later, Glazov et al. performed a randomized controlled trial comparing the effects of laser acupuncture (LA) and sham laser treatment in reducing pain and disability in adults with chronic non-specific low back pain. Their results showed no effect of LA in reducing pain using infrared light at 0.2 J/point [7]. A possible reason for this result is dose dependency issue [8].

On the other hand, Fiore et al. [9] examined the short-term effects of high-intensity laser therapy versus ultrasound therapy for the treatment of low back pain in a randomized controlled trial without placebo control group. At the end of a 3-week intervention period with 5 treatments per week, participants in the laser therapy group showed a significantly greater decrease in pain and an improvement in related disability compared with the ultrasound group. This study suggests that laser therapy is a promising treatment option for the rehabilitation of low back pain.

3.1.2. *Myofascial pain*

LA has been used to treat myofascial pain in the masticatory musculature and trapezius muscles. Some trials focusing on the ability of LA to relieve myofascial pain found negative or contradictory results, which may reflect the poor methodologies used before 2001 [10]. In recent years, randomized controlled trials revealed significant decreases in pain during both rest and activity, and an increase in pain threshold in patients treated with LA compared to those treated with needle-acupuncture and placebo, respectively. Although no definite conclusions can be drawn due to the low number of participants ($n = 11$), LA may be a good treatment option for patients wanting a noninvasive, complementary therapy [11]. LA appears to be an effective form of acupuncture for the management of these conditions [12].

3.1.3. *Temporomandibular dysfunction*

The effectiveness of LLLT for the control of pain in patients with temporomandibular disorder (TMD) has been evaluated in studies with various research designs. In one study, LA was applied to acupuncture points in TMD patients, and the results showed significant pain reduction and improvement in the electromyographic behavior of masseter muscles in maximal habitual occlusion after treatment, but no significant improvement was observed in mandibular movement. This shows that LA may have an effect for controlling pain in TMD patients [13, 14].

3.1.4. *Lateral epicondylitis*

LLLT is a conservative treatment for lateral epicondylitis (LE). A recent systemic review evaluated therapeutic effects of LLLT in treating LE in terms of pain, grip strength, range of motion (ROM), and weight tests. The results revealed that applying LLLT on myofascial trigger points is an effective means for pain reduction and also led to increases in grip force, ROM, and weight test [15]. However, most of the reviewed studies, which were all several decades old, showed no significant differences between the laser treatment and the placebo groups [16]. This may be related to dose or wavelength effects. LLLT at optimal doses of 0.5–7.2 J at 904 nm and possibly 632 nm administered directly to the lateral elbow tendon insertions, has been shown to offer short-term pain relief and reduce LE disability. No serious side effects were reported in that study. This finding contradicts the conclusions of the previously mentioned review [16], which failed to assess treatment procedure, wavelength, or optimal dose [17].

3.1.5. *Knee osteoarthritis*

Laser acupuncture has been widely used in treating knee osteoarthritis. A study by the Western Ontario and McMaster Universities (WOMAC) found a significant decrease in pain score in knee osteoarthritis patients treated with LA compared sham treatment [18]. Yurtkuran et al. used a range of pain indices to investigate the effects and minimum effective dose of LA in treating this condition. Although they found some pain reduction in the placebo group, statistically significant reduction in knee circumference was observed only in the laser group. They concluded that LA was effective in reducing periarticular swelling. They also noticed different effects for different knee joint acupoints. The most common acupoints they used were Dubi (ST35) and Neixiyan (EX-LE 4) [19].

3.1.6. *Headache*

Several randomized controlled trials have found LA to be an effective treatment for headache, especially in children, including both migraine and chronic tension-type headaches [20, 21]. LA was shown to decrease headache intensity, duration of attacks, as well as number of headache days per month.

3.2. **Other conditions**

3.2.1. *Obesity*

LA has been reported to be effective in weight control. Wozniak (2003) compared the efficacy of a low-calorie diet with and without concurrent LA in reducing visceral obesity in postmenopausal women. They observed a significantly greater drop in body weight, body mass index, and waist-to-hip ratio with the combined treatment [22]. More recently, Hu et al. evaluated the therapeutic effects of LA in subjects with simple obesity using a non-restrictive diet protocol. Significant reductions in body weight and body mass index were seen after 4 weeks

of LA treatment. Moreover, patient compliance was high, since this is a comfortable and non-restrictive diet protocol [23].

3.2.2. *Carpal tunnel syndrome*

In patients with carpal tunnel syndrome (CTS), lower-level-laser therapy plus microamperes transcutaneous electric nerve stimulation (TENS) applied to acupuncture points has been shown to significantly reduce pain. In this study, both subjective (McGill Pain Questionnaire scores) and objective (sensory and motor latencies and Phalen and Tinel signs) measurements revealed that this combined approach was effective in treating CTS [24]. Branco examined the effects of various conservative treatments on CTS patients, including LA, TENS, needle acupuncture, and Chinese herbal medicine formulas, pain reductions were significantly greater with the LA compared to the other treatments, including some patients failed to have symptom relief after surgical release. Suggested mechanisms of pain reduction they proposed included increased adenosine triphosphate (ATP) at the cellular level, decreased inflammation, and temporarily increased serotonin level [25].

3.2.3. *Postoperative vomiting*

Postoperative nausea and vomiting (PONV) are frequent side effects of general anesthesia in children. In 1998, LA was shown to reduce PONV in children after strabismus surgery. In this study, laser stimulation of PC6 occurred 15 min before administration anesthesia and again 15 min after arriving in the recovery room. In the laser stimulation group, the incidence of vomiting was significantly lower (25%) than that in the placebo group (85%) [26]. In another study, Butkovic et al. compared the effectiveness of LA to that of metoclopramide in preventing PONV in children after sevoflurane anesthesia. There were no statistically significant differences between the LA and metoclopramide groups in occurrence or timing of vomiting ($P < 0.001$). They concluded that LA is equally as effective as metoclopramide in preventing PONV in children [27].

3.2.4. *Smoking cessation*

A prospective observational 2 year study showed that the Smokex-Pro method (Table 2) is an effective aid in smoking cessation. The treatment was well tolerated and showed only mild and temporary side effects. Additional advantages included lower cost and shorter treatment duration compared to other smoking cessation programs. However, controlled clinical trials are still needed to confirm the results of this study and to refine the treatment for maximum efficacy [28].

3.2.5. *Alcohol addiction*

Auricular acupuncture has been used in the treatment of alcohol addiction for many years. Zalewska-Kaszubska et al. performed a study aimed at intensifying this method by adding

laser biostimulation for treatment of patients with alcohol dependence syndrome. The patients received a single helium-neon laser neck biostimulation and 10 auricular acupuncture treatments with an argon laser. After 2 months of treatment, improvements in Beck Depression Inventory-Fast Screen (BDI-FS) scores and increases in beta-endorphin level were observed. These results suggest that laser therapy can be useful as an adjunct treatment for alcoholism [29].

3.2.6. *Asthmatic children*

It has been shown that LA significantly decreases mean weekly PFV as a measurement of bronchial hyper reactivity in asthmatic children. In this study there were no significant effects on FEV1, quality of life, or additional medication [30]. Another randomized control trial concluded that a single LA treatment offers no protection against exercise induced bronchoconstriction in pediatric and adolescent patients [31].

3.2.7. *Neurogenic pruritus*

Stellon described successful LA treatment in a 6-year-old girl with neurogenic pruritus of the abdomen, which was the first case report on LA treatment for this condition. The main advantage of using low energy laser light to stimulate points, as opposed to using acupuncture needles, was that it causes little or no sensation during the treatment which is particularly useful in pediatric population [32].

3.2.8. *Depression*

Depression is a major public health problem, and there is some evidence supporting the effectiveness of needle acupuncture in its treatment. Quah-Smith et al. investigated the effects of LA in treating depression patients and found that Depression Inventory scores decrease from baseline by 16.1 points in the intervention group and by only 6.8 points in the sham control group ($P < 0.001$). However, the beneficial effect was short-lived. The LA was well tolerated, with transient fatigue being the most common adverse effect [33]. Additional controlled clinical trials are needed to confirm the results of this study and to refine the treatment for maximum efficacy.

3.2.9. *Nocturnal enuresis*

LA therapy has been shown to be significantly more effective in reducing bed-wetting in primary monosymptomatic nocturnal enuresis patients compared to placebo treatment. In this study, they found no significant effects on maximal voided volume (first morning void excluded), maximal morning voided volume, voiding frequency, enuresis frequency before and after treatment, or nocturnal urine production after LA treatment. However, they did find significant increases in average daytime voided volume compared to the placebo group. They concluded LA was a safe but inefficient treatment for these patients [34]. However, a different study showed subtle effects on bladder reservoir function after LA

treatment [35]. In comparison with pharmacological therapy using desmopressin, another study showed no statistically significant differences in success rates between desmopressin therapy and LA. LA is an alternative, noninvasive, painless, cost-effective, and short-term therapy for children with primary nocturnal enuresis, normal bladder function, and high nighttime urine production [36].

3.2.10. Autonomic nervous activity of night shift workers

Many studies have demonstrated high levels of affective disorders in night-shift workers. Wu et al. examined the impact of LA on autonomic nervous system (ANS) and heart-rate variability (HRV) of such workers. Compared with a placebo group, the treatment group had a statistically significant improvement in high-frequency (HF) HRV, low-frequency (LF) HRV, and LF:HF HRV ratio. This suggests LA may increase vagal activity and suppression of cardiac sympathetic nerves and could be used to help patients who have circadian rhythm disorders [37].

3.2.11. Whiplash injuries

Following introduction of compulsory seat belt use in cars, whiplash injuries of the cervical spine have become commonplace. Current treatment approaches resolve symptoms within a short time in most cases, but a small proportion of patients still develop persistent health problems. Aigner et al. combined LA with cervical collar treatment and medication (paracetamol and chlormezanone) to treat whiplash patients. They did not observe significantly greater improvements in any outcome measure at any time for LA compared to the other treatment protocols [38].

3.2.12. Postural instability

It is well known that the risk of falling is high among elderly people. Bergamaschi compared the effectiveness of auriculopuncture, ultralow-power LA, and placebo treatment in improving postural control in an elderly population. Balance performance was measured on a force platform before and after treatment. Although the small sample size did not allow reliable statistical analysis, the observed balance improvements were remarkable, and some differences were observed between the two kinds of stimulation. They found that both LA and auriculopuncture reduced nociceptive interference, thus improving postural control [39].

3.2.13. Peripheral artery disease

Cardiovascular disease is the most common cause of death in humans. The use of acupuncture as a complementary and alternative treatment for cardiovascular disease has been suggested in both humans and animals. Possible advantages of using acupuncture are the low cost of treatment and the low risk of collateral damage when used in combination with other medical treatments. In 2010, a trial was performed to compare the effects of traditional acupuncture and LA on arterial pressure and peripheral circulation of the inferior limbs in patients with

circulatory deficiencies. The results showed that only those treated with LA exhibited a significant increase in systolic pressure in their lower limbs, with a resulting improvement in Revascularization Index. This suggests that different stimuli on acupuncture points generate different variations of peripheral resistance in the lower limbs [40].

3.2.14. Cerebral cortical and subcortical activations

As recent studies have demonstrated, acupuncture can elicit activity in specific areas of the brain. Siedentopf et al. investigated the cerebral effects of LA at both GB43 acupoints with functional magnetic resonance imaging. Their results showed that LA produced significant, predominantly ipsilateral, brain activation within the thalamus, nucleus subthalamicus, nucleus ruber, the brainstem, and the Brodmann areas 40 and 22. No significant brain activations were observed within the placebo group. The fact that the observed effects were primarily ipsilateral supports the assumption that LA is mediated by meridians, since they do not cross to the other side of the body [41].

4. Discussion and conclusions

LA is a non-invasive technique involving the stimulation of traditional acupoints with low-intensity, non-thermal laser irradiation. Its clinical application is widespread even though its mechanisms are not well understood. LLLT can decrease inflammation by reducing the levels of biochemical markers (prostaglandin E₂, messenger ribonucleic acid cyclooxygenase-2, IL-1 β , TNF- α), neutrophil influx, oxidative stress, edema, and hemorrhaging [42]. Analgesia induced by laser phototherapy is mediated by peripheral opioid receptors [43], however LA has both local and distant analgesic effects that may be mediated by different mechanisms.

LA combines the positive effects of traditional acupuncture with LLLT. Compared with needle-based methods for manipulating Qi, LA has the advantages of being non-invasive and aseptic. Moreover, it is painless and safe because no heat is generated during the procedure, and it is more effective in some medical condition and requires less time than needle-based acupuncture [23]. No side effects or complications resulting from LA have been reported in any study so far.

We have presented evidence supporting the use of LA in the treatment of various types of acute and chronic pain, postoperative nausea and vomiting, nocturnal enuresis, alcohol addiction, smoking cessation, obesity, and cerebral cortical activation (Table 2). Inappropriate selection of points and frequencies, insufficient energy and therapeutic sessions will lead to a failure in laser acupuncture therapy. Further studies are needed to better define optimal treatment parameters, including wavelength, dose, and intensity, and to maximize the physiological benefit and cost effectiveness of treatment (Figure 1). In conclusion, LA integrates traditional acupuncture with LLLT, and is effective in treating many conditions. In the hands of an experienced physician, LA can be an effective alternative treatment method in modern medicine.

Study	Subjects	Design	Parameters	Acupoints	Intervention	Results
Fiore et al, 2011 [9]	Low back pain n=30	RCT	1064 nm, 760 mJ/cm ² , pw	Trigger points	5 times/ week for 3 weeks	Greater decrease in pain and an improvement of related disability
Katsoulis et al, 2010 [11]	Myofascial pain n=108	NR, blind control study	690 nm, 40 mW, 40–60 J, 15 min	ST6, SI18, SI3, LI4	Twice a week for 3 weeks	Pain reduction > 50%
Hotta et al, 2010 [13]	TMD n=10	Case series	GaAlAs laser, 780 nm; 70 mW, 35 J/cm ²	LI4, HT3, ST6, ST7	Once a week for ten sessions	Improve painful symptoms and electromyographic activities of masseter muscles
Mazzetto et al, 2010 [14]	TMD n=40	RCT, double-blind	GaAlAs laser, 830 nm, 40 mW, 5 J/cm ²	Affected condyle lateral pole: superior, anterior, posterior, posterior-inferior	Twice a week for 4 weeks	Immediate decrease of painful symptoms and increased range of mandibular movements
Ren et al, 2010 [18]	Knee OA n=41	RCT	Semiconductor laser, 650 nm, 36 mW; and CO ₂ laser, 1006 nm, 200mW, 40 Hz; 2 min	ST35 and EX-LE 4	Thrice a week for 2 weeks, then twice a week for 4weeks	Improve the pain, stiffness and functional limitation of knee
Yurtkuran et al, 2007 [19]	Knee OA n=52	RCT	904 nm, 10 mW/cm ² , 4 mW, 0.48 J, 120 s	SP 9	5 times per week for 2 weeks	Reducing periarticular swelling
Gottschling et al, 2008 [20]	Headache n=43	RCT	30 mW, 830 nm, cw, 3.8 W/cm ² , 0.9 J/point, 30 s	Frontal: LI4, ST36; lateral: TE5, GB34; occipital: SI3, BL60; holocephalic: GV20	Once a week over 4 weeks	Headache decreased
Ebneshahidi et al, 2005 [21]	Tension Headache n=50	RCT	GaAsAl laser, 830nm, 39 mW/cm ² , 1.3 J/point, 43s	LU7, LI4, GB14, GB20 bilaterally	Thrice a week for 10 sessions	Improvement for headache intensity, median duration of attacks, and median number of days with headache per month

Study	Subjects	Design	Parameters	Acupoints	Intervention	Results
Wozniak et al, 2003 [22]	Viseral obesity after menopause n= 74	RCT	900 Hz, 24 mW, 0.1 J, 10–15 s/point, 150 s	CV12, ST36, ST25, LR3, PC6, HT7; auriculotherapy: 55, 87	Twice a week with low-calorie diet for 6 weeks	Higher efficacy in lowering body weight, body mass index and waist-to-hip-ratio
Hu et al, 2010 [23]	Simple obesity n=95 (M/F 22/73)	Case series	GaAlAs laser, 785 nm, 50 mW, 0.25 J/point	Stomach, Hunger, ST25, ST28, ST40, SP15, CV9	Thrice a week with non-restrictive diet for 4 weeks	Reduce body weight and body mass index
Naeser et al, 2002 [24]	CTS n=11	RCT	632.8 nm, cw, 15 mW on shallow acupoints; 904 nm, pulsed, 9.4 W on deeper points	PC7	35 to 45 min, thrice a week for 3-4wk	Significant decreases in MPQ score, median nerve sensory latency, and Phalen and Tinel signs
Branco et al, 1999 [25]	CTS n=36	open protocol study	HeNe laser, 670 nm, cw, 5 mW, 1-7 J/point, TENS; 904 nm, pw, 10 W, 1 J/point and/or needle acupuncture	PC7, 8, 9; LU9, 10, 11; LI1, 4; TE1, 5; SI1	Thrice a week for 4-5 weeks	33 of 36 hands (91.6%) no pain, or pain reduced by more than 50%
Schlager et al, 1998 [26]	PONV n=91	RCT	670 nm, 10 mW, cw, 30 s	PC6	15 min before induction of anaesthesia and 15 min after arriving in the recovery room	Lower incidence of PONV (25%)
Butkovic et al, 2005 [27]	PONV n=120	RCT	GaAlAs laser, 780 nm, 20 mW, cw, 1 J/point, 60 s	PC6	15 min before induction of anesthesia	Equally effective as metoclopramide in preventing PONV
Breivogel et al, 2011 [28]	Smoking cessation n=156	prospective observational study	Smokex-Pro method (electric stimulation and laser at 650 nm, 1.5 mW, 10 Hz)	Defined regions in the ear and nose	For 24 months	Long-term abstinence rates were 49.3% (1 year) and 47.95% (2 years)

Study	Subjects	Design	Parameters	Acupoints	Intervention	Results
Zalewska - Kaszubsk a et al, 2004 [29]	Alcohol addiction n=53	Case series	HeNe laser 632.8 nm, 25 mW (neck); Argon laser, 514 nm, 100 mW, 10 s (ear)	Neck and auricular acupoints: 82, 83, 87, 51, 55	For 20 days	Improved BDI-FS and increase in beta-endorphin level
Stockert et al, 2007 [30]	Asthmatic children n=17	RCT	670 nm, 10 mW, 20 s/point up to 16 points + probiotics	LU1, 5, 7, 9, 11; LI4, 6, 19, 20; BL13, 17, 18, 20, 21, 23; ST13, 25, 36, 40, 44; SP3, 6, 9, 10; HT3, 5, 7; SI3; KI3, 6, 8, 27; PC6; TE5, 15; GB3, 34, 40, 41; LR2, 3, 8, 13; CV4, 6, 9, 17, 21; GV4, 13	For 10 weeks	Decreased mean weekly Peak flow variability and days of acute febrile infections
Quah-Smith et al, 2005 [33]	Depression n=30	RCT	100 mW, 0.5 J, 5 s	LR14, CV15, CV14, HT7, LR8	Twice weekly for 4 weeks then weekly for a further 4 weeks	BDI scores fell from baseline by 16.1 points in the test group and by 6.8 points in the control group
Karaman et al, 2011 [34]	Nocturnal enuresis in children, n=91	RCT, single blind	635~670 nm, < 5 mW, 1 min/point	CV3, 4, 6, and bilateral SP6, ST36	Thrice a week for 4 weeks	Decreased the mean number of weekly bed-wetting episodes
Radvansk a et al, 2011 [35]	Monosymptomatic nocturnal enuresis n=31	RCT, single-blind	670 nm, 20 s	GV20, HT7, ST36, SP6, LR3, KI3, CV3, CV4, BL23, GV4	Thrice a week in the first 2 weeks, then Twice a week in the next 3 weeks	Increase in average daytime voided volume
Wu et al, 2009 [37]	Healthy night shift worker n=45	Case series	830 nm, 60mW, 9.7 J/cm ² , 10 min	PC6	Single treatment	Increase vagal activity and suppression of cardiac sympathetic nerves
Bergama schi et al, 2011 [39]	Postural instability n= 34	preliminary report	0.03 mW, 100Hz, 0.3 mJ/point	BL60, KI3, Auriculotherapy zones	Single treatment	Reduce nociceptive interference and improve postural control

Study	Subjects	Design	Parameters	Acupoints	Intervention	Results
Cunha et al, 2010 [40]	Peripheral artery disease n=40	RCT	AlGaAs laser, 650 nm, 2.4 J/cm ²	10 acupoints	Single treatment	Increase in systolic pressure of lower limbs, improvement in Revascularization Index
Siedentopf et al, 2005 [41]	Healthy male n=22	RCT	10 mW, 670 nm, cw	GB43	Time series RARARARAR (on: A/off: R)	Significant brain activations within the thalamus, nucleus subthalamicus, nucleus ruber, brainstem, Brodmann areas 40 and 22
Aigner et al, 2006 [38]	Whiplash injury n=45	RCT	HeNe laser, 632.8 nm, cw, 5 mW, 0.075 J/cm ² , 15 s	B10, B40, G20, G34, TE5, SI6, LG14; ear points 29, 37, 41, 55	Thrice a week for three weeks	No statistically significant advantage in the acute or chronic phase

Table 2. Summary table of clinical researches into laser acupuncture

BDI-FS: Beck Depression Inventory–Fast Screen, CTS: carpal tunnel syndrome, cw: continuous wave, MPQ: McGill Pain Questionnaire, NR: non-randomized, OA: osteoarthritis, PONV: Postoperative nausea and vomiting, pw: pulsed wave, RCT: randomized controlled trial, TMD: temporomandibular disorders.

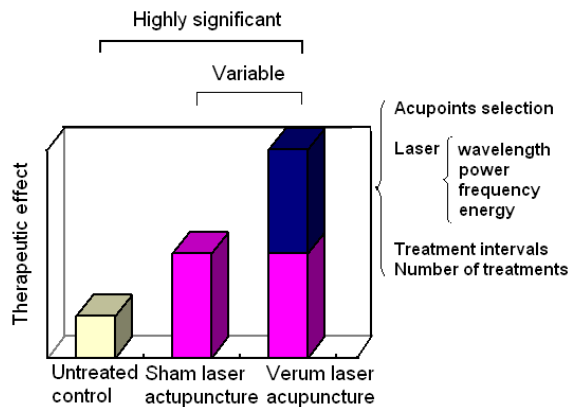


Figure 1. Graph of the therapeutic effects of laser acupuncture divided into psychological (pink) and physiological (dark blue) effects. The latter is determined by the shown factors

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References

- [1] Hill, S. Letter: Acupuncture research in the USSR. *American Journal of Chinese Medicine* (1976). , 4(2), 204-5.
- [2] Miklánek, J, & Kriz, V. st experiences with the utilization of lasers for acupuncture. The Akuplas device. *Fysiatrický a reumatologický vestník* (1978). , 56(1), 36-40.
- [3] Whittaker, P. Laser acupuncture: past, present, and future. *Lasers in Medical Science* (2004). , 19(2), 69-80.
- [4] Cigna Medical Coverage Policy: Low-Level Laser Therapy. (2012). http://www.cigna.com/assets/docs/health-care-professionals/coverage_positions/mm_0115_coveragepositioncriteria_lowlevel_laser_therapy.pdf.
- [5] Baxter, G. D, Bleakley, C, & Mcdonough, S. Clinical effectiveness of laser acupuncture: a systematic review. *Journal of Acupuncture and Meridian Studies* (2008). , 1(2), 65-82.
- [6] Glazov, G. The influence of baseline characteristics on response to a laser acupuncture intervention: an exploratory analysis. *Acupuncture in Medicine* (2010). , 28(1), 6-11.
- [7] Glazov, G, Schattner, P, Lopez, D, & Shandley, K. Laser acupuncture for chronic non-specific low back pain: a controlled clinical trial. *Acupuncture in Medicine* (2009). , 27(3), 94-100.
- [8] Baxter, G. D. Laser acupuncture: effectiveness depends upon dosage. *Acupuncture in Medicine* (2009).
- [9] Fiore, P, Panza, F, Cassatella, G, Russo, A, Frisardi, V, Solfrizzi, V, & Ranieri, M. Di Teo L, Santamato A. Short-term effects of high-intensity laser therapy versus ultrasound therapy in the treatment of low back pain: a randomized controlled trial. *European Journal of Physical and Rehabilitation Medicine* (2011). , 47(3), 367-373.

- [10] Fargas-babjak, A. Acupuncture, transcutaneous electrical nerve stimulation, and laser therapy in chronic pain. *The Clinical Journal of Pain* (2001). , 17(4), 105-13.
- [11] Katsoulis, J, Ausfeld-hafter, B, Windecker-gétaz, I, Katsoulis, K, Blagojevic, N, & Mericske-stern, R. Laser acupuncture for myofascial pain of the masticatory muscles. A controlled pilot study. *Schweizer Monatsschrift für Zahnmedizin* (2010). , 120(3), 213-25.
- [12] Baxter, G. D, Bleakley, C, & Mcdonough, S. Clinical effectiveness of laser acupuncture: a systematic review. *Journal of Acupuncture and Meridian Studies* (2008). , 1(2), 65-82.
- [13] Hotta, P. T, Hotta, T. H, Bataglioni, C, & Bataglioni, S. A. de Souza Coronatto EA, Siésere S, Regalo SC. Emg analysis after laser acupuncture in patients with temporomandibular dysfunction (TMD). Implications for practice. *Complementary Therapies in Clinical Practice* (2010). , 16(3), 158-60.
- [14] Mazzetto, M. O, Carrasco, T. G, & Bidinelo, E. F. de Andrade Pizzo RC, Mazzetto RG. Low intensity laser application in temporomandibular disorders: a phase I double-blind study. *The Journal of Craniomandibular Practice* (2007). , 25(3), 186-92.
- [15] Chang, W. D, Wu, J. H, Yang, W. J, & Jiang, J. A. Therapeutic effects of low-level laser on lateral epicondylitis from differential interventions of Chinese-Western medicine: systematic review. *Photomedicine and Laser Surgery* (2010). , 28(3), 327-36.
- [16] Haker, E, & Lundeberg, T. Laser treatment applied to acupuncture points in lateral humeral epicondylalgia. A double-blind study. *Pain*. (1990). , 43(2), 243-7.
- [17] Bjordal, J. M, Lopes-martins, R. A, Joensen, J, Couppe, C, Ljunggren, A. E, Stergioulas, A, & Johnson, M. I. A systematic review with procedural assessments and meta-analysis of low level laser therapy in lateral elbow tendinopathy (tennis elbow). *BMC Musculoskeletal Disorders* (2008).
- [18] Ren, X. M, Wang, M, Shen, X. Y, Wang, L. Z, & Zhao, L. Clinical observation on acupuncture irradiation with combined laser or red light on patients with knee osteoarthritis of yang deficiency and cold coagulation type. *Zhongguo Zhen Jiu* (2010). , 30(12), 977-81.
- [19] Yurtkuran, M, Alp, A, Konur, S, Ozçakir, S, & Bingol, U. Laser acupuncture in knee osteoarthritis: a double-blind, randomized controlled study. *Photomedicine and Laser Surgery*. (2007). , 25(1), 14-20.
- [20] Gottschling, S, Meyer, S, Gribova, I, Distler, L, Berrang, J, Gortner, L, Graf, N, & Shamdeen, M. G. Laser acupuncture in children with headache: a double-blind, randomized, bicenter, placebo-controlled trial. *Pain*. (2008). , 137(2), 405-12.
- [21] Ebneshahidi, N. S, Heshmatipour, M, Moghaddami, A, & Eghtesadi-araghi, P. The effects of laser acupuncture on chronic tension headache--a randomized controlled trial. *Acupuncture in Medicine* (2005). , 23(1), 13-8.

- [22] Wozniak, P, Stachowiak, G, Pięta-dolińska, A, & Oszukowski, P. Laser acupuncture and low-calorie diet during visceral obesity therapy after menopause. *Acta Obstetrica et Gynecologica Scandinavica* (2003). , 82(1), 69-73.
- [23] Hu, W. L, Chang, C. H, & Hung, Y. C. Clinical observations on laser acupuncture in simple obesity therapy. *The American Journal of Chinese Medicine* (2010). , 38(5), 861-7.
- [24] Naeser, M. A, Hahn, K. A, Lieberman, B. E, & Branco, K. F. Carpal tunnel syndrome pain treated with low-level laser and microamperes transcutaneous electric nerve stimulation: A controlled study. *Archives of Physical Medicine and Rehabilitation* (2002). , 83(7), 978-88.
- [25] Branco, K, & Naeser, M. A. Carpal tunnel syndrome: clinical outcome after low-level laser acupuncture, microamps transcutaneous electrical nerve stimulation, and other alternative therapies--an open protocol study. *The Journal of Alternative and Complementary Medicine*. (1999). , 5(1), 5-26.
- [26] Schlager, A, Offer, T, & Baldissera, I. Laser stimulation of acupuncture point reduces postoperative vomiting in children undergoing strabismus surgery. *British journal of anaesthesia* (1998). , 6.
- [27] Butkovic, D, Toljan, S, Matolic, M, Kralik, S, & Radesiæ, L. Comparison of laser acupuncture and metoclopramide in PONV prevention in children. *Pediatric Anesthesia* (2005). , 15(1), 37-40.
- [28] Breivogel, B, Vuthaj, B, Krumm, B, Hummel, J, Cornell, D, & Diehl, A. Photoelectric stimulation of defined ear points (Smokex-Pro method) as an aid for smoking cessation: a prospective observational 2-year study with 156 smokers in a primary care setting. *European Addiction Research* (2011). , 17(6), 292-301.
- [29] Zalewska-kaszubska, J, & Obzejta, D. Use of low-energy laser as adjunct treatment of alcohol addiction. *Lasers in medical science* (2004). , 19(2), 100-4.
- [30] Stockert, K, Schneider, B, Porenta, G, Rath, R, Nissel, H, & Eichler, I. Laser acupuncture and probiotics in school age children with asthma: a randomized, placebo-controlled pilot study of therapy guided by principles of Traditional Chinese Medicine. *Pediatric Allergy and Immunology* (2007). , 18(2), 160-6.
- [31] Gruber, W, Eber, E, Malle-scheid, D, Pflieger, A, Weinhandl, E, Dorfer, L, & Zach, M. S. Laser acupuncture in children and adolescents with exercise induced asthma. *Thorax*. (2002). , 57(3), 222-5.
- [32] Stellon, A. The use of laser acupuncture for the treatment of neurogenic pruritus in a child--a case history. *Acupuncture in Medicine* (2005). , 23(1), 31-3.
- [33] Quah-smith, J. I, Tang, W. M, & Russell, J. Laser acupuncture for mild to moderate depression in a primary care setting--a randomized controlled trial. *Acupuncture in Medicine* (2005). , 23(3), 103-11.

- [34] Karaman, M. I, Koca, O, Küçük, E. V, Öztürk, M, Güne, M, & Kaya, C. Laser acupuncture therapy for primary monosymptomatic nocturnal enuresis. *The journal of Urology* (2011). , 185(5), 1852-6.
- [35] Radvanska, E, Kamperis, K, Kleif, A, Kovács, L, & Rittig, S. Effect of laser acupuncture for monosymptomatic nocturnal enuresis on bladder reservoir function and nocturnal urine output. *The journal of Urology* (2011). , 185(5), 1857-61.
- [36] Radmayr, C, Schlager, A, Studen, M, & Bartsch, G. Prospective randomized trial using laser acupuncture versus desmopressin in the treatment of nocturnal enuresis. *European Urology* (2001). , 40(2), 201-5.
- [37] Wu, J. H, Chen, H. Y, Chang, Y. J, Wu, H. C, Chang, W. D, Chu, Y. J, & Jiang, J. A. Study of autonomic nervous activity of night shift workers treated with laser acupuncture. *Photomedicine and laser surgery* (2009). , 27(2), 273-9.
- [38] Aigner, N, Fialka, C, Radda, C, & Vecsei, V. Adjuvant laser acupuncture in the treatment of whiplash injuries: a prospective, randomized placebo-controlled trial. *Wiener Klinische Wochenschrift* (2006).
- [39] Bergamaschi, M, Ferrari, G, Gallamini, M, & Scoppa, F. Laser acupuncture and auriculotherapy in postural instability--a preliminary report. *Journal of Acupuncture and Meridian Studies* (2011). , 4(1), 69-74.
- [40] Cunha, R. G, Rodrigues, K. C, Salvador, M, & Zangaro, R. A. Effectiveness of Laser treatment at acupuncture sites compared to traditional acupuncture in the treatment of peripheral artery disease. *Engineering in Medicine and Biology Society (EMBC), 2010 Annual International Conference of the IEEE* (2010). , 2010, 1262-5.
- [41] Siedentopf, C. M, Koppelstaetter, F, Haala, I. A, Haid, V, Rhomberg, P, Ischebeck, A, Buchberger, W, Felber, S, Schlager, A, & Golaszewski, S. M. Laser acupuncture induced specific cerebral cortical and subcortical activations in humans. *Lasers in Medical Science* (2005). , 20(2), 68-73.
- [42] Bjordal, J. M, Johnson, M. I, Iversen, V, Aimbire, F, & Lopes-martins, R. A. Photoradiation in acute pain: a systematic review of possible mechanisms of action and clinical effects in randomized placebo-controlled trials. *Photomedicine and Laser Surgery* (2006). , 2, 158-68.
- [43] Serra, A. P, & Ashmawi, H. A. Influence of Naloxone and Methysergide on the Analgesic Effects of Low-Level Laser in an Experimental Pain Model. *Revista Brasileira de Anestesiologia* (2010). , 60(3), 302-310.