Systematic Review and Meta-Analysis

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Clinical efficacy of low-level laser therapy in plantar fasciitis

A systematic review and meta-analysis

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Abstract

Background: Emerging evidence suggests that low-level laser therapy (LLLT) for plantar fasciitis (PF) may be beneficial. However, the convincing study investigating its effectiveness for treatment of PF was scarce. Therefore, a systematic review and meta-analysis was conducted to assess whether LLLT significantly relieve pain of patients with PF.

Methods: PubMed, EMBASE, EBSCO, Web of Science, China Biological Medicine Database, China National Knowledge Infrastructure, Chinese Wan fang, and Cochrane CENTRAL were searched systematically up to March 2018.

Results: A total of 6 randomized controlled trials were included. The meta-analysis indicated that compared with control group, visual analogue scale (VAS) score significantly decreased at the end point of the treatment in LLLT group. In addition, this improvement is continued for up to 3 months. However, no significant difference was observed according to the Foot Function Index-pain subscale (FFI-p).

Conclusion: This meta-analysis indicates that the LLLT in patients with PF significantly relieves the heel pain and the excellent efficacy lasts for 3 months after treatment.

Abbreviations: AOFAS-F = function subscale of American Orthopedic Foot and Ankle Society Score, BMI = body mass index, CI = confidence interval, ESWT = extracorporeal shock wave therapy, FFI-p = Foot Function Index-pain subscale, LLLT = low-level laser therapy, PF = plantar fasciitis, PRISMA = Preferred Reporting Items for Systematic Review and Meta-Analyses, RCTs = randomized controlled trials, SMD = standard mean difference, VAS = visual analogue scale.

Keywords: low-level laser therapy, meta-analysis, pain, plantar fasciitis

1. Introduction

Plantar fasciitis (PF) is the predominant cause of heel pain.[1] The incidence of PF is estimated at 10%, and the PF occurs in 40 to 60 years old population commonly,[2,3] especially including women, soldiers, athletes, and obese individuals.[4,5] Generally, patients suffer pain at the first step in the morning, and feel a little of alleviation from moderate activity, but the symptoms are aggravated due to prolonged weight-bearing activity.[3,6] The argument on the diverse etiologic possibilities of PF is ongoing. The biomechanical dysfunction, pes planus, mechanical overload, obesity, improper shoe fit and wear were thought to be associated with this disease.[7] Decades ago, it was thought that inflammatory responses played a vital role in the pathological process.[1,8] Rather, emerging studies suggest that it is a degenerative process.[9]

Nowadays, there are different invasive and noninvasive management strategies for PF, including nonsteroidal antiinflammatory drugs, oral analgesics, physical therapy, stretch exercise, foot orthotics, corticosteroid injection, platelet-rich plasma injection and botulinum toxin injection.[10–13] Although numerous studies reported that corticosteroid injection, as one of the most popular treatment for PF, may be effective to relieve pain in a short period of time,[14,15] it may lead to serious adverse events such as PF rupture.[16]

Low-level laser therapy (LLLT) is based on the principles of photochemistry that militates via photochemical or nonthermal effects on cells.[17] Considerable studies have reported that LLLT could cure a variety of diseases, including subacromial impingement syndrome,[18] acute and chronic pain,[19] stroke,[20] temporomandibular disorder,[21] oral mucositis,[22] lymphedema,[23] and carpal tunnel syndrome.[24] In recent years, LLLT has been used to relieve pain caused by PF.[25] Cinar et al reported that LLLT could significantly increase function subscale of American Orthopedic Foot and Ankle Society Score total score at 3 weeks and effectively improve walking distance and walking surface.[26] Additionally, ultrasound imaging results suggested that after LLLT intervention, plantar fascia thickness was significantly decreased when compared with that in the placebo group.[27] In 2017, a systematic review of laser therapy about PF was reported.[28] However, only 2 trials were included due to the limited documents. In this context, the purpose of this systematic review is to conduct an update and evaluate the usefulness and safety of LLLT in the treatment of PF.

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2. Materials and methods

2.1. Search strategy

The study was conducted in accordance with guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-analysis group (PRISMA).[29] Ethical approval was not necessary because all analyses were based on previous published studies. The electronic databases including PubMed, EMBASE, EBSCO, Web of Science, China Biological Medicine Database, China National Knowledge Infrastructure, Chinese Wanfang and Cochrane CENTRAL were systematically searched for the literatures between the establishment date and March 2018. The following search terms were used: plantar fasciitis (PF), plantar fasciopathy, and laser. In addition, the reference lists of the resulting publications and reviews were also searched for relevant literature. The literature search was limited to English and Chinese publications.

2.2. Selection criteria

The studies were selected according to the inclusion criteria: adult patients who were diagnosed with plantar heel pain or PF; experimental groups accepted LLLT alone or LLLT combined with other interventions; control groups accepted placebo or other interventions; reported data on at least 1 pain score, such as VAS; English or Chinese language publications; and randomized controlled trial (RCT).

The exclusion criteria were as follows: no pain score was reported; not RCT; reviews, case report, abstract or animal studies; and duplicated data.

2.3. Data extraction

Data extraction was independently extracted by 2 authors, and disagreements were resolved by the third author. The extracted data included name of the first author, publication year, country,

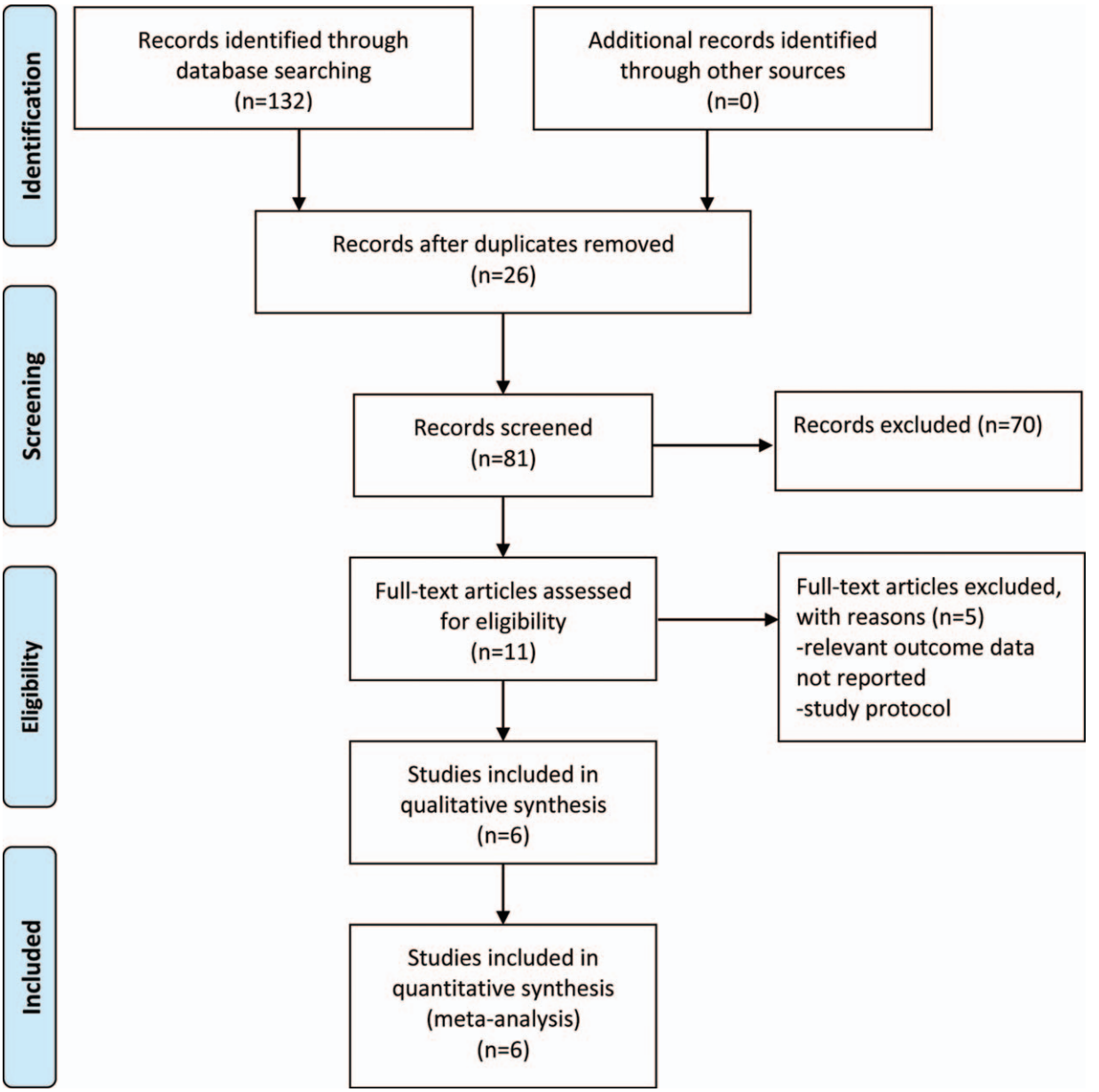

Figure 1. Flow diagram of included studies.

study sample size, patient characteristics, treatment modality, follow-up duration, and outcomes.

2.4. Risk of bias assessment

The Cochrane Collaboration risk of bias tool was used to assess the quality of RCT.[30] All included studies were assessed in 6 domains: random sequence generation, allocation concealment, blinding of investigators and participants, blinding of outcome assessment, incomplete of outcome data, selective reporting and other bias. Each domain has the low, unclear, or high risk.

2.5. Statistical analysis

Statistical analysis was performed using RevMan 5.3 (The Cochrane Collaboration, Software Update, Oxford, UK) and Stata 12.0 (StataCorp, College Station, TX). For all, continuous outcomes were expressed as standard mean differences (SMDs) with 95% confidence intervals (95%CIs). A *P*-value of $<.05$ was considered to be statistically significant. Chi-squared test and I^2 statistic test values were calculated to test the heterogeneity across studies. An I^2 value $\geq 50\%$ or chi-squared value <0.05 was considered significant heterogeneity. A random effects model was adopted when significant statistical heterogeneity was identified. Otherwise, the fixed effects model was used. Sensitivity analysis was performed to detect the influence of a single study on the overall estimate via omitting 1 study in turn when necessary. Publication bias was assessed through Begg and Egger tests.

3. Results

3.1. Search results

The initial literature search identified 132 studies, from which 26 studies were excluded due to the duplication. According to the inclusion and exclusion criteria, 6 RCTs[26,27,31–34] were finally included in this meta-analysis (Fig. 1). Two articles[33,34] were published in Chinese, and 4[26,27,31,32] were in English. The characteristics of the included trials are provided in Table 1. Of the 6 RCTs, 2 studies[27,31] compared LLLT with placebo, 1 article[34] compared LLLT plus low-intensity focused ultrasound with low-intensity focused ultrasound, 1 trial[33] described LLLT plus extracorporeal shock wave therapy (ESWT) versus ESWT, and 2 trials[26,32] compared a combination of LLLT and a usual care with usual care alone.

3.2. Methodological quality

Although all included studies claimed randomization, only 5 studies used the method of random sequences generation.[26,27,31,32,34] Only 3 studies performed allocation procedure.[26,27,32] Four studies reported the blinding of participants and personnel.[26,27,31,32] And, 2 studies claimed the blinding of outcome assessors.[27,31] Three studies reported the incomplete outcome data.[26,27,32] The quality of these included studies is displayed in Figure 2.

3.3. Meta-analysis

3.3.1. VAS score. The present meta-analysis is based on VAS and FFI-p scales. A total of 5 studies[26,27,31,33,34] with 274 patients provided analyzable data about VAS between LLLT group and control group. The meta-analysis demonstrated that VAS score was significantly reduced in the LLLT group (SMD = −0.95; 95% CI −1.20 to −0.70; $P<.001$) (Fig. 3). Begg test ($P=.642$) and Egger test ($P=.504$) indicated no significant publication bias (Fig. 4). Additionally, compared with control group, VAS score was better in LLLT group at 3-month follow-up (SMD = −1.13; 95% CI −1.53 to −0.72; $P<.001$) (Fig. 5).

3.3.2. FFI-p score. Two studies[31,32] with 110 patients reported the FFI-p. Results indicated that no significant difference was found in the FFI-p (SMD = −0.15; 95% CI −0.52 to 0.23; $P=.449$) (Fig. 6). Besides, absence of adverse effects was found in 6 studies. The results are consistent with previous data that

Table 1

Characteristics of the included studies.

Study	Year	Country	Sample size(L/C)	Age(year) (L/C)	Interventions(T/C)		Main outcomes	Follow-up
Kiritsi et al	2010	Greece	15/15	41/41	LLLT (GaAs, 904 nm), A total of 680.4 j in 157.5 s. 18 sessions in 6 week	Placebo	VAS,PFT	–
Macias et al	2015	USA	37/32	NR	LLLT (diode laser, 635 nm), 10 min. 6 sessions in 3 weeks	Placebo	VAS, PFT, FFI	–
Cinar et al	2017	Turkey	27/22	46.59/44.18	LLLT (GaAlAs, 830 nm), A total of 16.8 j in 240 s, 3 times in a week with a total of 10 sessions + usual care	Usual care, 3 times in a week with a total 10 sessions	VAS, AOFAS-F, 12-min walking test	3m
Cinar et al	2018	Turkey	24/17	46.5/44.0	LLLT (GaAlAs, 830nm), 5.6 j in 5 to 7 min, 3 times in a week with a total of 10 sessions + usual care	usual care, 3 times in a week with a total 10 sessions	FFI-p, NRS-p	3m
Li et al	2015	China	30/30	NR	LLLT(semiconductor,810nm), 8~12 min, 7 times in a week with a total of 15 sessions + ESWT, 1000–1200 shots, 1 times in 3 days with a total of 5 sessions	ESWT, 1 times in 3 days with a total of 5 sessions	VAS, NRS	3m
Xiao et al	2016	China	33/33	41/43	LLLT(semiconductor,660nm), 10 min, 7 sessions per week with a total of 30 sessions + LIFU, 10 min, 7 sessions per week with a total of 30 sessions	LIFU, 10 min, 7 sessions per week with a total of 30 sessions	VAS	–

AOFAS-F = function subscale of American Orthopedic Foot and Ankle Society Score, ESWT = extracorporeal shock wave therapy, FFI = Foot Function Index, FFI-p = Foot Function Index-pain subscale, LIFU = low-intensity focused ultrasound, LLLT = low-level laser therapy, NR = not reported, NRS = Numerical Rating Scale, NRS-p = Numerical Rating Scale for pain, PFT = Plantar fascia thickness, VAS = visual analogue scale.

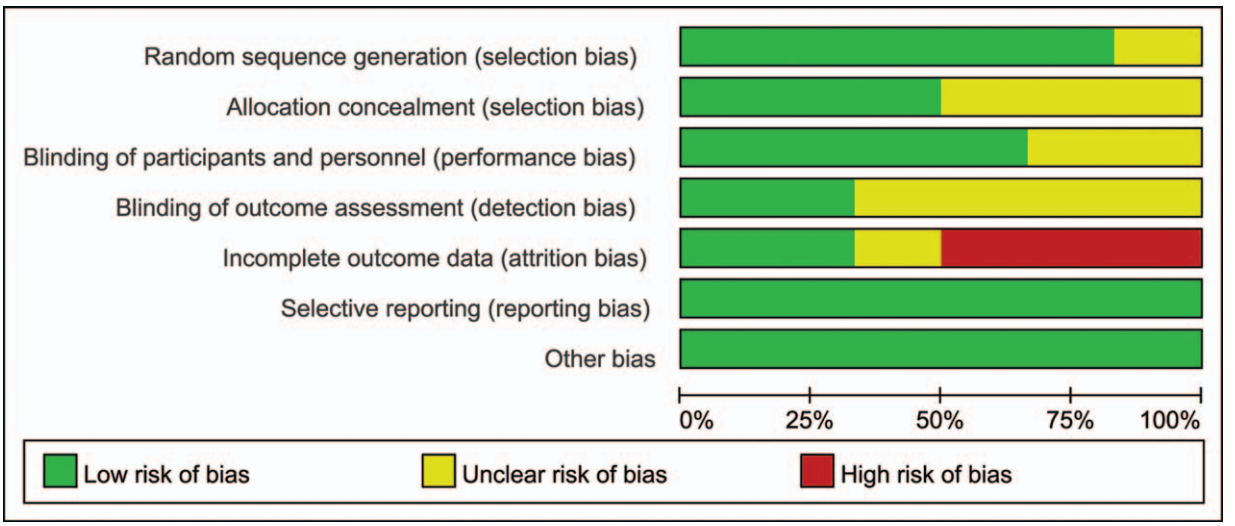

Figure 2. Risk of bias graph.

showed laser therapy is safe, well tolerated, and less painful for the patients.

4. Discussion

In this study, a systematic review and meta-analysis was conducted to evaluate the effect of LLLT treatment of PF. Overall, the analysis suggested that LLLT can significantly relieve pain of PF for 3 months after treatment. The results of our review are consistent with the findings of previous studies, suggesting benefits of LLLT in heel pain caused by PF.[28] Our meta-analysis showed that LLLT intervention indeed alleviated pain as indicated by the decreased VAS score. In addition, compared with the baseline values, the VAS score was also significantly decreased at the period of 3-month follow-up after LLLT.

Despite LLLT have many applications in clinic, the exact mechanisms accounting for LLLT-mediated pain relief have not been identified. And some previous studies described a series of mechanisms as follows: peripheral neural blockade, enhancement of peripheral endogenous opioids, suppression of central synaptic activity, inhibition of histamine release, modulation of neurotransmitters, promotion of adenosine triphosphate (ATP) production, reduction of muscle spasm, and increased production of antiinflammatory cytokines.[35–39]

It is reported that there are several controversial cases about the LLLT treatment for PF, which might be due to the differences in

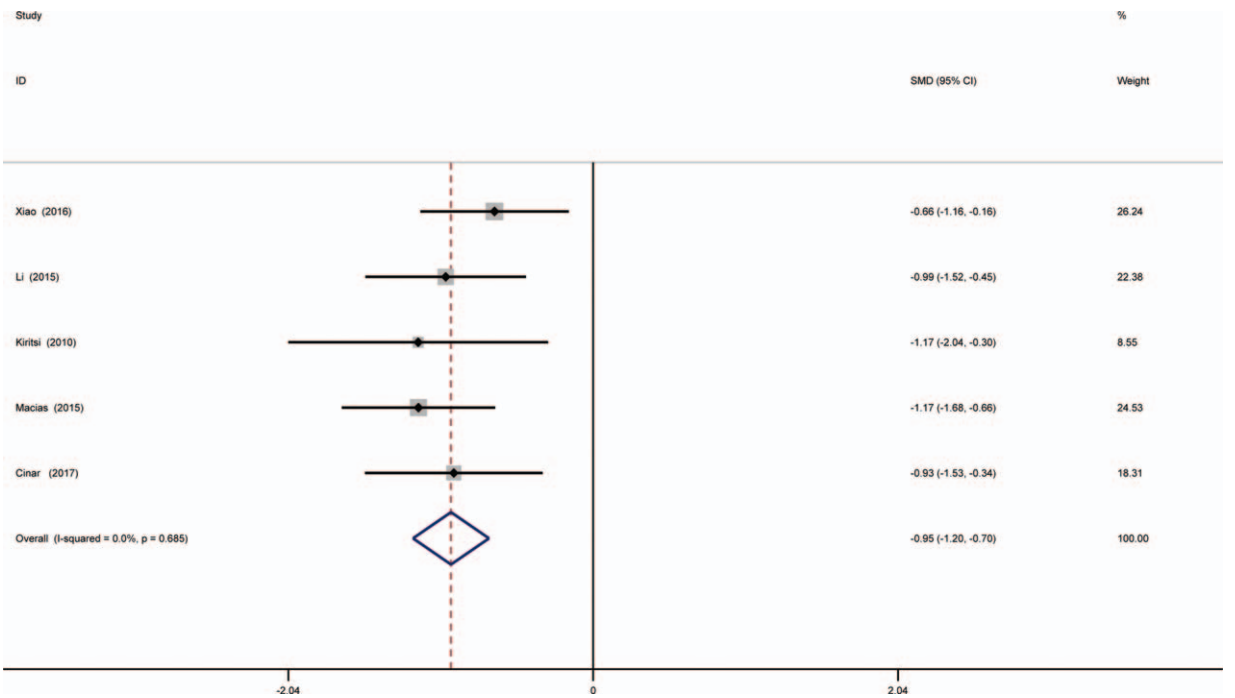

Figure 3. Forest plot of VAS between 2 groups. CI = confidence interval, SMD = standardized mean difference, VAS = visual analogue scale.

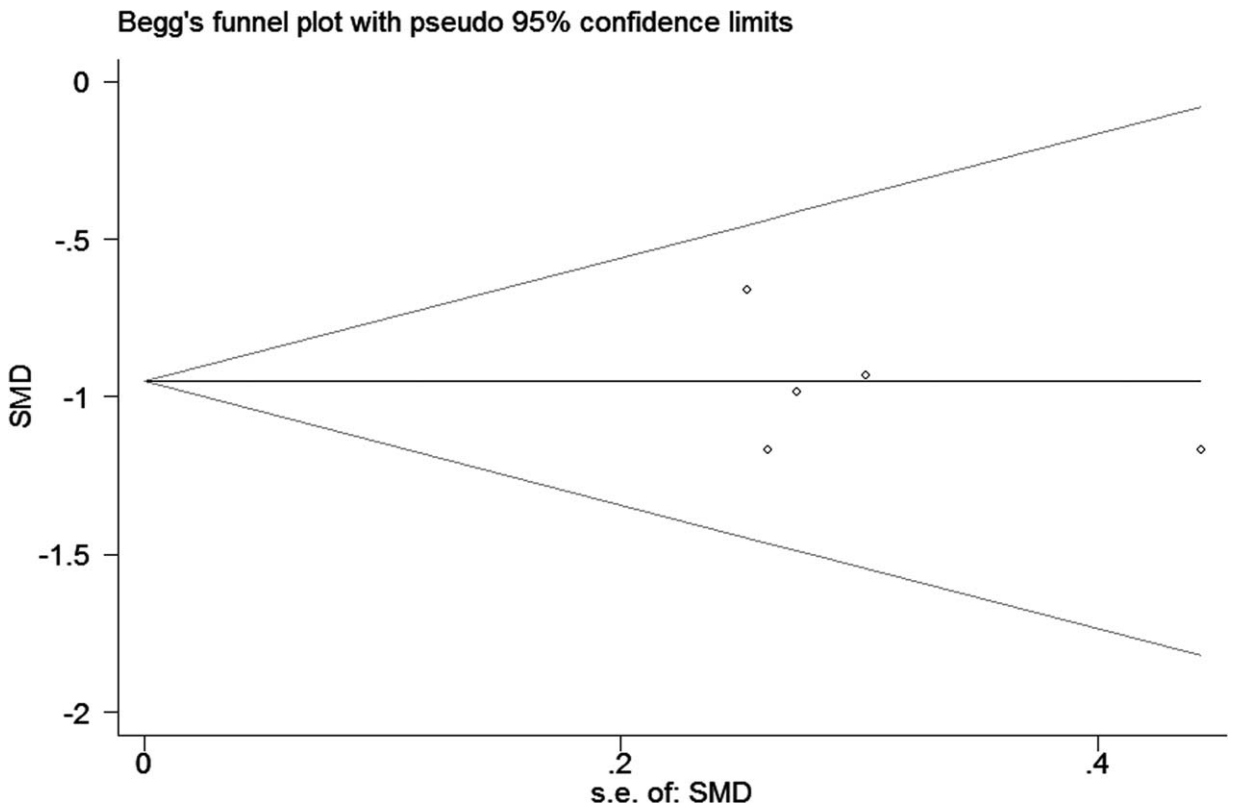

Figure 4. Begg funnel plot of included studies.

the treatment protocols and types of LLLT. In general, 2 types of laser are used for PF: He-Ne laser and GaAlAs/GaAs laser. A prospective study showed that GaAlAs laser can significantly improve the pain of PF.[25] However, Macias et al[31] reported that pain attenuation was not obvious under the same treatment protocol. Compared with He-Ne laser, the efficacy of GaAlAs/GaAs laser was performed better with deeper penetration. Several studies showed that patients suffering from PF could benefit from the GaAlAs/GaAs.[26,27,40] Conversely, Basford et al[41] reported that the application of GaAlAs could not improve the pain of PF. The inconsistencies in the efficacy of GaAlAs/GaAs laser may result from different doses. Basford et al[41] reported that their

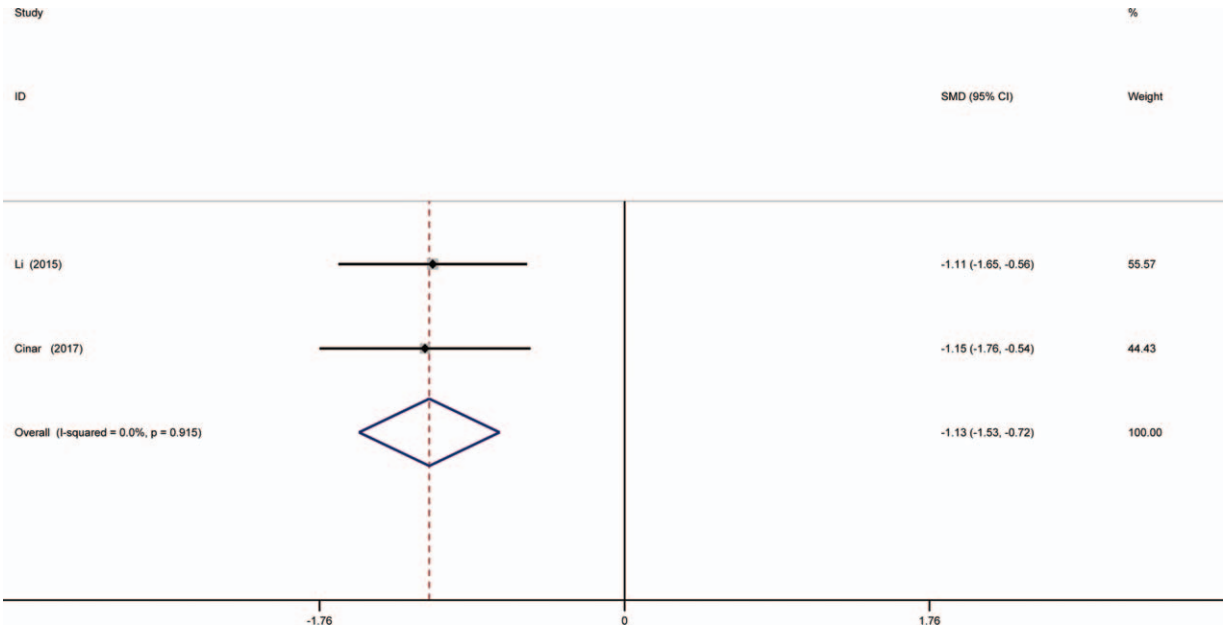

Figure 5. Forest plot of VAS between 2 groups at 3 months. CI = confidence interval, SMD = standardized mean difference, VAS = visual analogue scale.

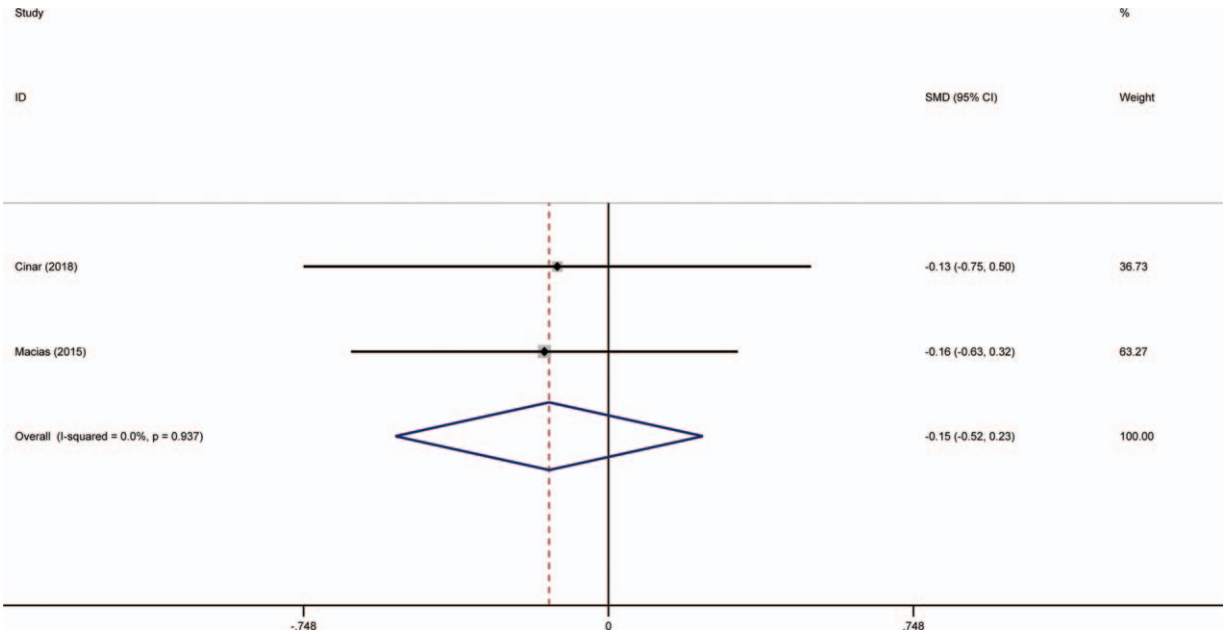

Figure 6. Forest plot of FFI-p between 2 groups. CI = confidence interval, FFI-p = Foot Function Index-pain subscale, SMD = standardized mean difference.

treatment protocol was 1 J to the calcaneal origin and 2 J to the over the fascial arc, which is less than LLLT treatment PF recommended as treatment dose of a minimum of 8 J. In contrast, Ulusoy et al[40] applied LLLT at 8 J to the medial calcaneal area and the myofascial junction. Kiritsi et al[27] applied at 8.4 J to the tendon insertion and the medial side of the fascia. As the therapeutic application of LLLT involves multiple variables, such as dose, locations, and frequency, it is unclear that which one is the optimum protocol. Therefore, future research should focus on exploring optimal treatment parameters to improve its treatment clinical efficacy.

This meta-analysis has some limitations. First, only 6 studies were included, and sample size was relatively small. Second, this meta-analysis lacks sufficient evidence to analyze the underlying influence factors (such as body mass index (BMI)) that may influence the effect of LLLT treatment. Third, the included studies lack sufficient data regarding longer-term outcomes of LLLT. Therefore, this study is only relevant short-term (up to 3 months) comparison data. Finally, the outcome just was obtained based on VAS, and other objective index (such as heel tenderness index and PF thickness) was not universally used in all included studies. Despite these limitations, the present meta-analysis still provided important clinical treatment information.

In conclusion, this meta-analysis demonstrated that LLLT may effectively relieve the heel pain of patients with PF, at least in the short term (i.e. 3 months). However, more large-scale, well-designed studies are needed urgently to further clarify long-term efficacy and optimal treatment parameters of LLLT.

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