Low level laser therapy for nonspecific low-back pain (Review)

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ABSTRACT

Background
Low-back pain (LBP) and related disabilities are major public health problems and a major cause of medical expenses, absenteeism and disablement. Low level laser therapy (LLLT) can be used as a therapeutic intervention for musculoskeletal disorders such as back pain.

Objectives
To assess the effects of LLLT in patients with non-specific low-back pain and to explore the most effective method of administering LLLT for this disorder.

Search strategy
We searched CENTRAL (The Cochrane Library 2005, Issue 2), MEDLINE and CINAHL from their start to January 2007 and EMBASE, AMED and PEDro from their start to 2005 with no language restrictions. We screened references in the included studies and in reviews of the literature and conducted citation tracking of identified RCTs and reviews using Science Citation Index. We also contacted content experts.

Selection criteria
Only randomised controlled clinical trials (RCTs) investigating low level laser therapy as a light source treatment for non-specific low-back pain were included.

Data collection and analysis
Two authors independently assessed methodological quality using the criteria recommended by the Cochrane Back Review Group and extracted data. Consensus was used to resolve disagreements. Clinically and statistically homogeneous studies were pooled using the fixed-effect model; clinically homogeneous and statistically heterogeneous studies were pooled using the random-effects model.

Main results
Six RCTs with reasonable quality were included in the review. All of them were published in English. There is some evidence of pain relief with LLLT, compared to sham therapy for subacute and chronic low-back pain. These effects were only observed at short-term and intermediate-term follow-ups. Long-term follow-ups were not reported. There was no difference between LLLT and comparison groups for pain-related disability.

There is insufficient evidence to determine the effectiveness of LLLT on antero-posterior lumbar range of motion compared to control group in short-term follow-up. The relapse rate in the LLLT group was significantly lower than in the control group at six months follow-up period according to the findings of two trials.

Authors' conclusions
No side effects were reported. However, we conclude that there are insufficient data to draw firm conclusions.

There is a need for further methodologically rigorous RCTs to evaluate the effects of LLLT compared to other treatments, different lengths of treatment, different wavelengths and different dosages. Comparison of different LLLT treatments will be more reasonable if dose calculation methods are harmonized.

PLAIN LANGUAGE SUMMARY

Low level laser therapy for low-back pain

Sixty to eighty per cent of people suffer from back pain at some time in their lives. Of those who develop acute low-back pain (LBP), up to 30% will go on to develop chronic LBP. The toll on individuals, families and society makes the successful management of this common, but benign condition an important goal.

Low level laser therapy (LLLT) is a therapeutic intervention for back pain that is used by some physiotherapists. Low level laser therapy is a non-invasive light source treatment that generates a single wavelength of light. It emits no heat, sound, or vibration. It is also referred to as photobiology or biostimulation. LLLT is believed to affect the function of connective tissue cells (fibroblasts), accelerate connective tissue repair and act as an anti-inflammatory agent. Lasers with different wavelengths, varying from 632 to 904 nm, are used in the treatment of musculoskeletal disorders.

We included six small studies with a total of 318 people with non-specific low-back pain of varying durations. Three of the studies (126 people) showed that, on average, LLLT was more effective at reducing pain in the short-term (less than three months) than sham (fake) laser. However, the strength and number of treatment were varied and the amount of the pain reduction was small. Two other studies (112 people) showed that, on average, LLLT was more effective at reducing pain in the intermediate-term (six months) than sham laser. The treatment doses were similar in these two studies, but the population and number of treatments were different.

Three studies (126 people) showed that, on average, LLLT was no more effective at reducing disability in the short-term than sham laser. Once again, strength and number of treatment doses and populations were varied. Another trial (120 people) showed a reduction in pain, disability and analgesic use for the two groups who received a series of LLLT treatments compared to the group who received sham laser.

Based on these small trials, there are insufficient data to either support or refute the effectiveness of LLLT for the treatment of LBP. We had hoped to answer the questions of optimal dose, application techniques or length of treatment, but were unable to with the available evidence. There were also no trials comparing LLLT to other treatments for low-back pain. Further trials are required that are larger and look specifically at these questions.

BACKGROUND

Low-back pain (LBP) and related disabilities are major public health problems and major causes of medical expenses, absenteeism and disablement (van Tulder 1995). Sixty to eighty per cent of people suffer from back pain at some time in their lives (Andersson 1997; Waddell 2004). Of all adults complaining of back pain, only about five per cent can be classified as having nerve root pain (using strict diagnostic criteria), with the remainder having back pain with or without referred leg pain, which is commonly referred to as non-specific low-back pain (Waddell 2004). Of those who develop acute LBP, up to 30% will go on to develop chronic LBP. The past 15 years have seen an intensive research effort to identify effective treatments and management strategies for low-back pain (Nachemson 2000).

Acute non-specific LBP is a benign and self-limiting condition. Once serious pathology (red flags) has been ruled out, current guidelines for the management of acute back pain recommend pain management interventions plus reassurance and advice to stay active as the interventions of choice (Waddell 2004). The aim of conservative (non-surgical) treatments for LBP is usually to relieve pain and associated disability. Recommended treatment options are diverse but there is sound evidence for only a minority of these therapies (CRD 2000; Nachemson 2000).

Low level laser therapy (LLLT) is currently used by some physiotherapists as a therapeutic intervention for musculoskeletal disorders such as back pain (Beckerman 1992; Bjordal 2003). Low level laser therapy is a light source treatment that generates light of a single wavelength. It emits no heat, sound, or vibration. Instead of producing a thermal effect, LLLT may act by non-thermal or photochemical reactions in cells. It is also referred to as photobiology or biostimulation (Basford 1989; Baxter 1991). Low level laser therapy is thought to affect fibroblast function and accelerate connective tissue repair (Kreisler 2002). It has also been reported that LLLT has anti-inflammatory effects due to its action in reducing prostaglandin synthesis (Sakurai 2000). Most LLLT lasers are Class 3a or Class 3b (Baxter 1991). Class 3a LLLTs have a power output of less than 5 mW, and Class 3b LLLTs have an output of less than 500 mW. Low level laser therapy lasers can be either visible or invisible.

Some studies suggest that LLLT has a beneficial anti-inflammatory and pain attenuation effect in humans (Ceccherelli 1989; Mizokami 1993). Research in humans on wound healing and anti-inflammatory effects of LLLT showed conflicting results (Baxter

1991). The effectiveness of laser therapy in painful disorders is still unclear and needs to be examined more rigorously (Beckerman 1992).

OBJECTIVES

1) To assess the effectiveness of LLLT for the treatment of non-specific low-back pain.

2) To explore the most effective method of administering LLLT for non-specific low-back pain, including the optimal:

- dosage
- application techniques
- length of treatment

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

Published reports of completed randomised controlled trials (RCTs) were included. There were no restrictions on the basis of language or date of trial.

Types of participants

Trials that included male or female subjects aged 18 years and over, with acute (pain for four weeks or less), subacute (pain for one to three months) or chronic low-back pain (pain for more than three months) were included (van Tulder 2003). Low-back pain was defined as pain localised between the shoulder blades and the folds of the buttocks, with or without radiation to the legs (CRD 2000).

Trials that included subjects with low-back pain caused by specific pathological entities such as infection, metastatic diseases, neoplasms, osteoporosis, rheumatoid arthritis, fracture, inflammatory processes or radicular syndrome were excluded.

Trials that discussed musculoskeletal disorders were included if a separate analysis was reported for low-back pain.

Types of intervention

Low level laser therapy (LLLT) is a light source that generates pure light, of a single wavelength with non-thermal effects (Baxter 1991). We included reports of studies that explored the effects of all types of LLLT (Classes I, II, and III), including all wavelengths, compared to another treatment. The comparison interventions were no treatment, sham procedures or other therapeutic interventions.

Types of outcome measures

We chose outcomes for this review based on those recommended by the Cochrane Back Review Group (Deyo 1998). The primary outcomes were:

- Low-back pain measured by visual analogue scale (Huskisson 1974), box scale (Jensen 1989), McGill Pain Questionnaire (Melzack 1987) or other validated quantitative measures.
- Low-back-related disability measured by the Oswestry disability questionnaire (Fairbank 1980), Roland-Morris disability scale (Patrick 1995; Roland 1983) or other validated quantitative measures.

Secondary outcomes were:

- Overall improvement or satisfaction with treatment as rated by either participants or therapists.
- Health-related quality of life as measured by questionnaires such as the SF-12 (Ware 1996), SF-36 (Ware 1992), or EuroQoL (EuroQoL 1990).
- Return-to-work, days of absenteeism, or days of reduced activities (Deyo 1998).
- Physical examination: measuring range of motion, spinal flexibility, or muscle strength.
- Side effects, adverse effects, medication use and health care use.

To be eligible for this review, studies had to have measured at least one of the outcomes.

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

See: Cochrane Back Group methods used in reviews.

Relevant studies meeting the inclusion criteria were identified by:

- A computer-aided search of CENTRAL (The Cochrane Library 2005, issue 2), MEDLINE (1966 to January 2007), EMBASE (1988 to March 2005), CINAHL (1982 to January 2007), AMED (the Allied and Complementary Medicine Database, 1985 to March 2005) and PEDro- the physiotherapy evidence database (http://www.pedro.fhs.usyd.edu.au/index.html) (to March 2005)
- Screening references given in relevant reviews and identified RCTs.
- Citation tracking of identified RCTs and reviews using Science Citation Index
- Communication with Managing Editor, Back Review Group for additional RCTs.
- Personal contact with content experts.

The search strategy in Additional Table 1 (Table 01) was used for MEDLINE(OVID) and CINAHL(OVID), based on van Tulder 2003.

For EMBASE, the search strategy suggested by the Back Review Group (van Tulder 2003) was used. Search words used for the PEDro database were: low back pain, back pain, backache, lumbar, dorsalgia, lumbago, laser, infrared, effectiveness, treatment, therapy. A similar process was used for AMED.

METHODS OF THE REVIEW

Selecting trials for inclusion:
All the citations identified by the above searches were downloaded into a reference manager database. Two authors with expertise in medicine, physiotherapy, laser therapy and research methods (ES and RYN), non-blinded to authors and publication journals, independently screened for inclusion, using the pre-specified criteria. If it was clear from the abstract that the study did not meet the selection criteria, it was excluded. If it was unclear from the abstract whether the study met the selection criteria, the full paper was retrieved. Two authors (MAK and SAMH), using the same selection criteria used for the abstract screening, read the full paper and made final selection decisions. Any discrepancies were resolved by discussion, followed, if necessary, by a third reviewer (RYN) if disagreement persisted.

For studies that were excluded following review of the full text, reasons for exclusion were detailed in the table of *Characteristics of Excluded Studies*, with a summary provided in the text of the review.

Assessment of Methodological Quality:
Two reviewers (MAK and SI) independently assessed the methodological quality of each RCT. Disagreements were dealt with by discussion and consensus in review team (ES, AR and RYN).

The 11 criteria recommended by the Back Review Group were used to assess the methodological quality of the RCTs (van Tulder 2003). Each criterion was scored as "yes"," no" or "unclear", depending on how successfully the criterion was met. The criteria for evaluating the internal validity and their operationalization are found in Additional Table 02.

If the study provided "unclear" information on methodological criteria, the authors were contacted for additional information. If no response was obtained from authors or if the information was no longer available, these criteria remained 'unclear'.

We had planned a sensitivity analysis to determine whether the overall results were the same when studies above different methodological cut-off points were synthesized (van Tulder 2003), but were unable to because of lack of studies.

Data extraction:
Two reviewers (MAK and SI) independently extracted the data on study design, participants, interventions and outcomes. Data extraction was not blinded to authors and journal of publication. Data were extracted and entered into Review Manager 4.2 for the calculation of summary statistics. Disagreements on the results of data extraction were resolved by consensus. If disagreement persisted, a third reviewer (RYN) was consulted.

Laser characteristics and dosages were recalculated based on the data available in the articles or from personal contacts. The World Association of Laser Therapy acknowledges that incomplete dosage reporting is a major problem, and recommends that review authors recalculate laser dosages of primary studies (WALT-a 2005). We calculated power, density (mW/cm^2) and dose (J) for each study. Power density for pulse lasers (mW/cm^2) was calculated by multiplying the peak power pulse by the pulse duration and then by the pulse frequency and dividing the total by the spot size on the skin. Power density for lasers with continuous output (mW/cm^2) was calculated by dividing the mean power by the spot size on the skin. Dose (J) was calculated by multiplying the mean power by the treatment time per session. Authors were contacted to provide sufficient information for recalculation. Based on the recommended anti-inflammatory dosage for low level laser therapy developed by the WALT (WALT-b 2005), the minimum dose for irradiating 904 nm lasers to the lumbar spine is 4 J per point. Recommended doses are based on ultrasonographic measurements of depths from skin surface and typical volume of pathological tissue and estimated optical penetration for the different laser types in Caucasians. According to these recommendations, included articles were divided into adequate and inadequate dosing subgroups (see Table 04).

Analysis:
The statistical analysis followed the recommendations of the Cochrane Handbook (CC Handbook 2005) and the Back Review Group (van Tulder 2003). The results of each RCT were plotted as point estimates with corresponding 95% confidence intervals (95% CI). Potential sources of clinical heterogeneity were identified. For studies judged as clinically homogeneous, statistical heterogeneity was tested by the Q test (chi-square) and I^2. Clinically and statistically homogeneous studies were pooled using the fixed effect model. If data were statistically heterogeneous ($P < 0.1$), reasons for heterogeneity were explored. Regardless of any evidence of statistical heterogeneity, the influence of specific differences between the RCTs was investigated. Clinically homogeneous and statistically heterogeneous studies were pooled using the random effects model. Standardized mean differences (SMD), or weighted mean differences (WMD) with 95% CI were calculated for each outcome. Because pain, quality of life or functional status were measured with similar but not identical instruments, SMD instead of WMD were calculated. We selected a 20-mm change in pain on a 100-point pain scale, or 30% as the minimum clinically significant difference (MCID) for pain scores, based on Farrar 2001, who suggests an absolute difference

of two points on 0 to 10 numeric scale and other studies that suggest that the minimum clinically significant change is not an absolute number but a range, that depends on the baseline values and duration of pain (van der Roer 2006).

To create a pooled effect measure, the team examined possible sources of clinical heterogeneity by considering:

- methodological study quality;
- population differences in age, gender;
- duration of symptoms (i.e. acute versus chronic);
- low-back pain aetiology;
- intervention type by laser class, treatment protocol, treatment duration and irradiation sites;
- outcomes [i.e. subject reports of pain and pain relief, range of motion, other measures of performance (i.e. activities of daily living, disability, function), or employment status].

Outcomes were presented separately for less than three months after randomisation (short-term follow-up), between three months and one year (intermediate follow-up), or longer than one year (long term follow-up). Subgroup analysis was performed for adequate and inadequate laser dosing according to power density and irradiated energy.

Sub-group analyses were planned for acute, sub-acute or chronic low-back pain, but because of insufficient number of studies were not carried out. Similarly, sensitivity analysis, meta-regression and publication bias tests were planned but not carried out because of insufficient numbers of studies.

When the data could not be entered in the meta-analysis because of the way the authors of the trials reported the results (for example: no information about standard deviation of the means) we performed a qualitative analysis by attributing levels of evidence to the effectiveness of low level laser therapy, taking into account the methodological quality and the outcome of the original studies (van Tulder 2003):

- **Strong evidence*** - consistent** findings among multiple higher quality RCTs
- **Moderate evidence** - consistent findings among multiple lower quality RCTs and/or one higher quality RCT
- **Limited evidence** - one lower quality RCT
- **Conflicting evidence** - inconsistent findings among multiple trials (RCTs)
- **No evidence** - no RCTs

* There is consensus among the Editorial Board of the Back Review Group that strong evidence can only be provided by multiple higher quality trials that replicate findings of other researchers in other settings.

** When more than 75% of the trials report the same findings.

DESCRIPTION OF STUDIES

In total, we found six small trials (318 people) that met the inclusion criteria.

The populations included in the trials had a diagnosis of non-specific LBP, but differed with respect to duration of pain, previous treatments and distributions of age. One study (Longo 1991) was limited to patients with acute pain but the duration was not clear in the report and some patients might have suffered from an acute exacerbation of chronic low-back pain. Another trial included patients with LBP of at least one-month duration (Basford 1999), but the mean duration of pain in the laser and control groups was seven and 13 months respectively. In another study (Soriano 1998), patients over the age of 60 with LBP of at least three months were included. Two other trials (Gur 2003; Klein 1990) were limited to patients with chronic pain (more than one year). Toya 1994 had no limitations for the duration of pain. The lumbar pain group (41 patients) in this study consisted of lumbago (23), ischiatic neuralgia (9), lumbar musculofascial pain (2), herniated disc (3), lumbar spondylosis (4).

The types of laser, dose, duration and frequency of treatments varied among the studies. Five studies(Gur 2003; Klein 1990; Longo 1991; Soriano 1998; Toya 1994) used infrared diode lasers. Only one study used a 1060 nm Nd-Yag laser (Basford 1999). Irradiation energy densities were recalculated based on the information provided in the reports and if possible, directly from authors. Laser doses ranged from 0.1 J (Klein 1990) to 48.8 J (Basford 1999). Only three studies (Basford 1999; Soriano 1998; Toya 1994) used sufficient laser dosage according to WALT-b 2005 recommendations (Table 04). Basford 1999 used a Nd-Yag laser with some thermal effects. This study was included because the laser dose was sufficient based on WALT recommendations and the laser was considered low level laser by the authors.

In three studies (Longo 1991; Soriano 1998; Toya 1994), treatment duration was less than two weeks; in others it was about four weeks. The number of treatment sessions differed from one session in Toya 1994 to 20 sessions in Gur 2003. All studies irradiated painful areas, except Longo 1991, in which the laser targets were painful areas and trigger points. In two studies (Gur 2003; Klein 1990), exercise therapy was used in both the laser and control groups similarly. The exercise programs in these studies were considered to be comparable.

With respect to the outcome measures, pain intensity was used in all except one study (Longo 1991), and measured with a visual analogue scale (VAS) on a 0 to 100 scale. Three studies (Basford 1999; Gur 2003; Klein 1990) assessed disability using validated questionnaires and lumbar range of motion. Pain relapse rate was measured in two studies (Longo 1991; Soriano 1998). Only one

study reported self-rated overall improvement (Longo 1991). The timing of outcome measures varied from "immediately after the end of sessions" to one year after randomisation.

Details about each included trial are given in the table of *Characteristics of included studies*.

METHODOLOGICAL QUALITY

The results of the methodological quality assessment are shown in Table 03. All studies were described as randomised; however the method of randomisation was explicit in only three studies (Basford 1999; Klein 1990; Toya 1994). One study (Basford 1999) used a block randomisation method for patient allocation. We remained unsure about the effectiveness of the randomisation in this study because there was a big difference in the duration of pain between the two groups (seven months in the laser group and 13 months in the control group). Allocation to treatment groups was concealed in two studies (Klein 1990; Toya 1994). Patients and care providers were blinded in all studies except one (Gur 2003). Outcome assessors were blinded in five trials (Basford 1999; Gur 2003; Klein 1990; Longo 1991; Toya 1994). The drop-out rate and loss to follow-up in the data analysed were less than 20% in all studies but one (Soriano 1998), where 21% were excluded from final analysis in the control arm, while there were only 11% excluded from the experimental group. Two studies conducted an intention-to-treat analysis (Gur 2003; Klein 1990). For more details about the criteria met in each trial, see Table 02. The quality scores of the included studies according to the criteria recommended by the Back Review Group's method guidelines (van Tulder 2003) ranged from six to 11.

RESULTS

Study selection:
Our searches resulted in the identification of 59 reports in MEDLINE, 107 in EMBASE, 35 in CINAHL, 9 in AMED, 577 in PEDro and 28 in CENTRAL. After removing duplicates, 142 reports were screened in the next step. After exclusion of irrelevant trials, we obtained hard copies of 34 trials, including 25 English, 3 German, 2 Russian, 2 Polish, one Japanese and one Italian. Of these, 24 were primary studies, but only five trials met the inclusion criteria. Reasons for the exclusion of these studies are explained in the table of *Characteristics of Excluded Studies*. We contacted the primary authors of trials and experts in the field of LLLT to obtain additional information that was not reported in the published studies. One expert informally discussed this review with some other experts in the field of LLLT. One article was found in this phase (Longo 1991). When we updated the literature search to January 2007, two more potential references were located. One was excluded; the other is listed under 'Studies awaiting assessment', pending the receipt of additional information from the author and will be addressed in the update of this review.

LLLT versus sham treatment
Pain:
The pooled analysis of three trials (n = 126) showed that LLLT was more effective than sham for patients with chronic low-back pain without neurologic symptoms for reducing pain (short-term follow-up) with a WMD -11.33, (95% CI: -16.91 to -5.75) (Basford 1999; Gur 2003; Klein 1990). All three studies used a 100-point VAS to measure the pain. There was no significant heterogeneity for comparison of pain, indicating that the difference between LLLT and control groups was consistent across trials.

One study (Basford 1999) used adequate laser dosing and two studies (Gur 2003; Klein 1990) used inadequate laser dosages. The WMDs of pain at short-term follow-up were -16 (95% CI: -27.95 to -4.05) and -10.03 (95%CI: -16.34 to -3.72) for adequate and inadequate subgroups respectively. The same results were seen when the studies with exercise therapy as a co-intervention in both study arms (Gur 2003; Klein 1990) were compared with the study without exercise therapy (Basford 1999).

One study (Soriano 1998) measured pain with a visual analogue scale but reported the results as the percentage of pain relief graded as poor, regular, good and excellent. In this study, at the six month follow-up, 44.7% of the patients in the LLLT group and 15.2% of the control group reported excellent relief (P < 0.01). In another study (Toya 1994), pain was graded as exacerbation, little or no change, fair, good, and excellent. The sum of the frequencies of patients with 'excellent', 'good' and 'fair' grades was defined as 'effective treatment' frequency. One day after treatment the percentage of 'effective treatment' was 94% (15/16) in the laser group and 48% (12/25) in the sham group (P = 0.007). The pain results in intermediate-term (three months to one year) and long-term follow-ups were not reported in any other studies.

In summary, five studies (238 people) showed significant pain relief with LLLT in short term and intermediate term follow-ups. Three of them used adequate dosing as defined by WALT-b 2005. However, because of the small trials and the clinical heterogeneity of the population, treatment and outcome measurements, there are insufficient data to support or refute the efficacy of LLLT to reduce pain for individuals with subacute or chronic LBP, when compared to a sham treatment, with or without the addition of exercises as co-interventions.

Disability:
Pain-related disability was measured using the Oswestry questionnaire (Basford 1999), Modified Oswestry questionnaire (Gur 2003) and a validated 24-item questionnaire (Klein 1990). The pooled analysis of three trials (n = 126) failed to show a difference in short-term disability measures between the LLLT and sham groups, with a pooled SMD of -0.14 (95% CI: -0.88 to 0.59) for patients with chronic low-back pain without neurologic symp-

toms. Only one study (Basford 1999), showed a significant improvement in disability measures with a SMD of -0.81 (95% CI: -1.36 to -0.26). It used an adequate dosing but a different type of laser and included a slightly different population of low-back pain. Gur 2003 and Klein 1990 used inadequate laser dosing, with a SMD of 0.21 (95%CI: -0.26 to 0.68). The same results were seen when the studies with exercise therapy as the co-intervention in both study arms (Gur 2003; Klein 1990) were compared to the study without exercise therapy (Basford 1999).

One study (Longo 1991) measured the overall efficacy of treatment using the Ritchie scale, which includes improvement in pain, functional deficit and analgesic deviation. These symptoms completely disappeared or improved in 97.5% of patients in the LLLT group and 37.5% of the control group after one month.

In summary, four studies (278 people) measured disability. However, because of the small trials and the clinical heterogeneity of the population, treatment and outcome measurements, there are insufficient data to support or refute the efficacy of LLLT to reduce disability in individuals with (sub)acute or chronic LBP, when compared to a sham treatment, with or without the addition of exercises as co-interventions.

Relapse rate:

The percentage of relapse was reported in two trials (Longo 1991; Soriano 1998). In one trial (Longo 1991), the relapse rates were reported after one month, six months and one year after the beginning of the study. Soriano 1998 reported the relapse rate at six months follow-up. Therefore, the pooled analysis (random-effects) of two trials (n = 151) shows that LLLT is more effective than sham for patients with (sub)acute or chronic low-back pain without neurologic symptoms on relapse rate (intermediate-term follow-up) with RR 0.43 (95%CI 0.28 to 0.65). Soriano 1998 used adequate laser dosage with a senior population with chronic LBP and Longo 1991 used inadequate dosage, with a working-aged population with acute LBP of undetermined duration. Both studies showed significant difference in relapse rate at intermediate-term follow-up.

Secondary Outcomes:

Three studies (Basford 1999; Gur 2003; Klein 1990) measured lumbar mobility. Two of them (Basford 1999; Gur 2003) assessed the range of motion in centimetres using the Schober test (Moll 1971). The other one (Klein 1990) measured it in degrees using a validated computerized isodynamic system. Because of the difference in the instruments the standardized mean difference was calculated. The pooled analysis of three trials (n = 126) using a fixed-effect method (because of the statistical homogeneity of results) failed to show a difference in anterior-posterior lumbar range of motion between the LLLT and control groups in short-term follow-up with a SMD of 0.01 (95% CI:-0.34 to 0.36). Comparing lumbar range of motion in short-term follow-up, one study (Basford 1999) used adequate dosing, resulting in a SMD of -0.05 (95% CI: -0.58 to 0.47), and two studies (Gur 2003; Klein 1990) used inadequate laser dosing, ending with a pooled SMD of 0.07 (95%CI: -0.40 to 0.54). The same results were seen when the studies with exercise therapy as a co-intervention in both study arms (Gur 2003; Klein 1990) were compared with the study without exercise therapy (Basford 1999).

However, as with other outcomes, because of the small trials and the clinical heterogeneity of the population, treatment and outcome measurements, there are insufficient data to support or refute the efficacy of LLLT.

One study (Basford 1999) reported the perception of benefit which was assessed using a visual analogue scale. At the one-month follow-up, the difference in the mean of perception of benefit in the laser and control groups was 9.5 mm (95% CI:-1.9 to 20.9).

Adverse effects:

Two studies reported neither discomfort related to laser treatment nor an increase in pain in either group (Klein 1990; Toya 1994). In Soriano 1998, five patients in the LLLT group (two abandoned and three needed to use NSAIDS) and nine patients in the control group (three abandoned and six needed to use NSAIDS) were lost to follow-up.

Due to ambiguity and overlap of the definitions of the duration of low-back pain, subgroup analyses for acute, sub-acute and chronic low-back pain were not performed.

DISCUSSION

The results for pain are based on five studies (Basford 1999; Gur 2003; Klein 1990; Soriano 1998; Toya 1994), three of which were pooled and showed a statistically significant improvement in pain relief after laser treatment in short-term and intermediate-term follow-ups. All five studies had reasonable quality (met at least 6 criteria) and all except two (Longo 1991, Toya 1994) included sub-acute or chronic non-specific low-back pain. Our findings suggest that low level laser therapy can be beneficial for pain relief in patients with chronic non-specific low-back pain. However, this improvement (WMD -11.3 mm on visual analogue scale) is less than the minimum clinically significant improvement (Farrar 2001). Therefore, when one considers this, along with the clinical heterogeneity of the studies, which reduces the confidence we can have in a pooled effect size, one is forced to question the efficacy of LLLT to improve back-related symptoms, based on the current literature. Other systematic reviews on the effects of LLLT on pain showed similar small effects on pain relief. The systematic review of the effectiveness of LLLT on rheumatoid arthritis (Brosseau 2006 A) suggested that LLLT was effective at reducing pain relative to placebo (WMD -11 mm). Another systematic review investigating the effectiveness of LLLT on joint disorders (Bjordal 2003) concluded that LLLT seemed to be effective in reducing pain due

to chronic joint disorders (WMD -29.8 mm). A Cochrane review on LLLT for osteoarthritis (Brosseau 2006 B) reported conflicting results of different studies about the effectiveness of low level lasers for pain. According to our findings, the pain relief effect of LLLT was sustained up to intermediate-term follow-up in some circumstances, as shown in the pain relapse rate findings. A possible explanation of the effects of LLLT on pain relief is its anti-inflammatory and connective tissue repair process which have been shown in some in vitro and in vivo studies (Sakurai 2000; Sattayut 1999; Skinner 1996).

We could not find any statistically significant improvement in low-back pain-related disability or range of motion after laser therapy. It may be due to the use of very low laser doses in the studies, which limits its efficacy. Only Basford 1999 study showed a significant improvement in disability measures, which used a higher laser dosage than other studies. Bjordal 2003 found that after adjustment for tissue penetration, many laser doses used in many of the trials are too low to have any significant anti-inflammatory effects at target locations. According to this limited evidence, it seems that LLLT effects are clinically modest and could not substitute for other beneficial interventions such as exercise therapy. The effectiveness of exercise and intensive multidisciplinary pain treatment programmes for chronic low-back pain is supported by strong evidence (Koes 2006).

LLLT may have some clinical effects on low-back pain in doses less than the minimum recommended doses of the World Association of Laser Therapy (WALT-b 2005). However, more research is needed on the optimal dose, wavelength and number of treatments before the recommendations could reasonably be changed.

No serious adverse events were reported in the trials included in this review, but the total sample size of included trials was small for judgment about the safety of this intervention.

Low power lasers are sometimes irradiated to acupuncture points in addition to painful areas. The rationale for laser acupuncture is vastly different from phototherapy. Instead of using the direct effect of light on tissues to initiate a physiological response, in laser acupuncture, the selection of points is based on a diagnostic and therapeutic paradigm defined in acupuncture theories (Chow 2006). Therefore laser acupuncture studies were excluded from the current review.

AUTHORS' CONCLUSIONS

Implications for practice

Based on the current literature, we conclude that there are insufficient data to draw firm conclusions on the efficacy of LLLT to reduce pain and disability in individuals with LBP. When infrared wavelengths are used, LLLT appears to have a small effect on pain intensity and frequency in patients suffering from chronic low-back pain, if applied to painful areas for at least two weeks. But, based on our findings, LLLT should not be substituted for other beneficial interventions such as exercise therapy.

Implications for research

There is a need for further methodologically rigorous RCTs evaluating different lengths of treatment, different wavelengths and different dosages. Comparison of different LLLT treatments will be more reasonable if dose calculation methods are harmonized. Cost-effectiveness studies are recommended.

POTENTIAL CONFLICT OF INTEREST

none

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** Indicates the major publication for the study*

TABLES

Characteristics of included studies

Study	Basford 1999
Methods	Study design: RCT; Unit of allocation: Patients; Method of randomization: bloc randomized with a computer generated schedule; Allocation concealment: inadequate; Blindedness: Double-masked
Participants	Randomized = 63; Analysed = 59 Recruitment of patients: announcement in the institutional newsletter and the local newsletter and by referal from local physicians; Enrollment dates: Not stated; Age: Between the ages of 18 and 70 years; Sex: Male and female; Ethnicity: Not stated; Work status: Not stated; Diagnosis of LBP: Localized pain and tenderness in the vicinity of the lumbosacral spine with normal neurologic examination results; Duration of pain: More than 30 days; Previous treatments: No treatment of this problem by a physician, physical therapist, chiropractor or health care provider in the previous 30 days. Analgesic and nonsteroidal antiinflammatory medication use was not encouraged but was monitored as an experimental variable; Exclusion criteria: Surgery (eg,fusion), Pending of litigation or workman's compensation issues, Corticosteroids for any reason in the last 30 days, Radicular pain(Described as pain extending below their bottoks, or noted changes in bowel or bladder function or lower exterimity strenght or sensation.) Women were recruited to be postmenopausal or practicing an effective means of birth control (pregnancy tests were obtained).
Interventions	Both arms of the trial were included: LLLT(27) and sham(29). Intervention group: laser, Three times a week, 4 week schedule by a masked therapist with the subjects removing their shirt and lying prone on a plinth. The therapist scrubbed the lumbar paraspinal muscles with an alcohol-soaked gauze pad; Laser medium:Nd-YAG; Laser model: Laser Biotherapy; Wave length(nm): 1060 nm; Laser mode: Continuous-wave; Output power: 1626 mW; Spot diameter(cm): not stated; Exposure

	time(seconds): 90 sec; Anatomic locations: At each of four equally spaced level (a total of 8 points) along the L2 to S3 paraspinal tissues Control group: Irradiated with the same, but inactive laser device
Outcomes	Measurements by: An experienced and masked physician and therapist not involved in the treatment; measured variables: Function(Oswestry disability questionnaire, validated), pain(visual analog scale,validated), lumbar mobility(a modification of the schober test), changes in medicatin use , activity level, perception of benefit, pain nature, and any adverse effects from treatment; Follow up sessions: sixth session, twelfth session, 28 to 35 days after the last treatment; Intention-to-treat analysis: no
Notes	Total score: 8
Allocation concealment	C – Inadequate

Study	**Gur 2003**
Methods	Study design: RCT; Unit of allocation: Patients; Method of randomization: Not stated; Allocation concealment: not used; Blindedness: Single blind
Participants	n = 75; Recruitment of patients: not stated; Enrollment dates: May 1999 and March 2000; Age: Between the ages of 20 and 50 years; Sex: Male and female; Ethnicity: Not stated; Work status: Not stated; Diagnosis of LBP: self-reported criteria plus information concerning the existence of medical conditions, medication use and the possibility of serious injuries.; Duration of pain: More than one year; Previous treatments: No previous spinal surgery; Exclusion criteria: neurological deficits, abnormal laboratory findings, systemic and psychiatric illnesses, pregnancy
Interventions	Two arms of the study were included: LLLT+exercise(25) and sham+exercise(25) Intervention group: laser+exercise, five times a week , 4 weeks; Laser medium:Gallium-Arsenide laser; Laser model: Frank Line IR 30, Fysiomed, Belgium; Wave length(nm): Not stated; Laser mode: Pulsed, 2.1 kHz pulse frequency; Output power: 10W, 4.2mW average power; Laser class: IIIb; Spot diameter(cm): 1.1cm; Exposure time(seconds): 4 min; Anatomic locations: the L4 to L5 and L5 to S1 apophyseal capsules, dorsolumbar fascia, and interspinous ligaments, as well as the gluteal fascia, posterior sacroiliac ligaments, hamstrings, and gastro-soleus muscles of which pain points were palpated from the low back to the foot Control group: exercise therapy: lumbar flexion and extension, knee flexion, hip adduction exercises, and strength exercises of extremity muscle groups/ first session of the exercises was conducted with a physiotherapist and continued at home by the patients themselves. two sessions a day, making a total of 40 sessions for 4 weeks
Outcomes	Measurements by: A physician who didn't know which therapy was taken evaluated the patients; Measured variables: Functioning(Roland Disability Questionnaire (RDQ) and Modified Oswestry Disability Questionnaire (MODQ)), Pain(visual analogue scale (VAS)), Lumbar range of motion(Schober test), flexion and lateral flexion measures; Follow up sessions: one month after therapy; Intention-to-treat analysis: no
Notes	Total score: 6
Allocation concealment	B – Unclear

Study	**Klein 1990**
Methods	Study design: RCT; Unit of allocation: Patients; Method of randomization: a computer generated random numbers table; Allocation concealment: yes; Blindedness: yes
Participants	n= 20 Recruitment of patients: By advertisement; Enrollment dates: Not stated; Age: Between the ages of 21 and 55 years; Sex: Male and female; Ethnicity: Not stated; Work status: Not stated; Diagnosis of LBP: Clinical features of back pain with prolonged maintenance of one posture, such as prolonged sitting, standing, or bending and temporary relief of symptoms witrh changing positions or walking; Duration of pain: More than

	one year; Previous treatments: No prior back surgery; Exclusion criteria: Acute exacerbation of chronic LBP, not pregnant, no prior surgery, not >10 pounds overweight, not involved in litigation or disability claims
Interventions	Both arms of the trial were included: LLLT+exercise(10) and sham+exercise(10). Intervention group: laser+exercise, three times a week , 4 weeks; Laser medium:Ga-As laser; Laser model: Omniprobe (laser biostimulation unit); Wave length(nm): 904nm; Laser mode: Pulsed, 1 kHz pulse frequency, 200 nsec pulse duration; Output power: 2W; Laser class: I; Spot diameter(cm): 1.1cm in each head with 10 heads; Exposure time(seconds): 240sec (4min) for each point [20 min of total stimulation time for each patient]; Anatomic locations: external over a series of standardized fields designed to include the L4 to L5 & L5 to S1 apophyseal capsules, dorsolumbar fascia, interspinous ligaments, gluteal fascia, posterior sacroiliac ligaments Control group: Home Exercise program: 50 full-forward flexion exercises performed in standing position followed by 25 extension exercises twice a day, walk briskly: 20 min a day, 2 sets of knee flexion coupled with hip abduction each day. Exercises were to be started on the first day of the study and countinuoud at least untill completion of all objective and subjective measurements.
Outcomes	Measurements by: a blinded physical therapist ; Measured variables: Disability score(a questionnaire of 24 items(validated)), Pain(VAS(0-7.5cm)), Lumbar function (range of motion/ isometric torque/ isodynamic velocities), the isotechnologies B100(a commercially available computerized isodynamic system)/ (validated); Follow up sessions: one month after therapy; Intention-to-treat analysis: yes
Notes	Total score: 11
Allocation concealment	A – Adequate

Study	**Longo 1991**
Methods	Study design: RCT; Unit of allocation: Patients; Method of randomization: Not stated; Allocation concealment:unclear; Blindedness: yes
Participants	n = 120 (40 to each of 3 groups), but only used 2 groups in this review, therefore n = 80 Recruitment of patients: Not stated; Enrollment dates: Not stated; Age: Between the ages of 40 and 65 years; Sex: Male and female; Ethnicity: Not stated; Work status: Not stated; Diagnosis of LBP: acute lumbago with degenerative or traumatic lesions visible in X-ray and without obvious signs of neurologic deficit ; Duration of pain: acute(?); Previous treatments: No previous therapy which interfers with the results of the experiment ; Exclusion criteria: Fracture, luxation, hernia of the nucleus pulposus
Interventions	Two arms of the trial were included: LLLT(40) and sham(40). Intervention group: laser, Treatment begun within 24hr of the onset of the symptoms once a day for 5 days,then another 5 on alternative days; Laser medium:Diode laser ; Laser model: Not stated; Wave length(nm): 904nm; Laser mode: Pulsed, 3 kHz pulse frequency, 200 nsec pulse duration; Output power: peak power 72W (27W?); Laser class: Not stated; Spot diameter(cm): 0.2 cm(1 cm2 spot area using lens correction); Exposure time(seconds): 5min/cm2 (of every radiation); Anatomic locations: Intervertebral holes, possible trigger points Control group: simulated laser irradiation
Outcomes	Measurements by: two blinded doctors; Measured variables: spontenous or induced pain(Ritchie scale for intensity of pain), level of reflected analgesic vertebral deviation(the angel of inclination in an AP X-ray (validation not mentioned)), functional limitation (percentage of normal movement of the sacral-lumbar area (validation not mentioned)); Follow up sessions: after 3 applications, after 5 applications, after one month, after six months, after one year; Intention-to-treat analysis: no
Notes	Total score: 7
Allocation concealment	B – Unclear

Study	**Soriano 1998**
Methods	Study design: RCT; Unit of allocation: Patients; Method of randomization: Not stated; Allocation concealment: no; Blindedness: yes

Characteristics of included studies (*Continued*)

Participants	randomized = 85; analyzed = 71 (5/43 dropped out from experimental group; 9/42 dropped out from control group) Recruitment of patients: Not stated; Enrollment dates: Not stated; Age: more than 60 years; Sex: Male and female; Ethnicity: Not stated; Work status: Not stated; Diagnosis of LBP: Not stated ; Duration of pain: >3 months; Previous treatments: The use of analgesic drugs and physical therapy was excluded in both groups, a wash-out period of 5 days was done on any patient on NSAIDs; Exclusion criteria: any suspicious of cancer, any suspicious of osteomyelitis, any suspicious of gout, any suspicious of paget's disease, any suspicious of collagen disease, symptoms or signs of neurologic deficits in the lower limbs, usage of long acting corticoids within the prior 30 days
Interventions	Both arms of the trial were included: LLLT(38) and sham(33). Intervention group: laser, five sessions a week for 2 weeks; Laser medium:Ga-As diode laser ; Laser model: Not stated; Wave length(nm): 904nm; Laser mode: Pulsed, 10 kHz pulse frequency, 200 nsec pulse duration; Output power: peak power 20W, average power:40 mW; Laser class: Not stated; Spot diameter(cm): 1.1cm?; Exposure time(seconds): 100; Anatomic locations: On painful area Control group: Sham irradiation with a deactivated laser radiation, but the electrical circuit, timer and alarm worked as usual so that to all intents and purposes it was exactly identical to the real system.
Outcomes	Measurements by: Not stated; Measured variables: pain(VAS), Radiologic findings (osteopoenia, osteophytes, narrowing of disc spaces, spondylolisthesis grade 1), physical examination; Follow up sessions: every 1 month for six months; Intention-to-treat analysis: no
Notes	Total score: 6
Allocation concealment	B – Unclear

Study	**Toya 1994**
Methods	Study design: RCT; Unit of allocation: Patients; Method of randomization: a computer generated schedule; Allocation concealment: adequate; Blindedness: Double-blinded
Participants	randomized = 130; analyzed 115, 41 of whom had LBP and were included in this review Recruitment of patients: patients attending their respective institution on an outpatient basis; Enrollment dates: Not stated; between the ages of 18 to 82y; Sex: Male and female; Ethnicity: Not stated; Work status: Not stated; Diagnosis of LBP: Not stated, Lumbar pain group(41 patients) consisted of Lumbago(23), Ischiatic neuralgia(9), Lumbar musculofascial pain(2), herniated disc(3), lumbar spondylosis(4); Duration of pain: not stated; Previous treatments: no limitations, a wash-out period was done on any patient on medications; Exclusion criteria: not stated
Interventions	Both arms of the trial were included: LLLT(16) and sham(25). Intervention group: laser, single session, no other treatments allowed; Laser medium:Ga-Al-As diode laser ; Laser model: OhLase-3D1(Proli, Japan); Wave length(nm): 830nm; Laser mode: continuous; Output power: 60 mW; Laser class: Not stated; Spot diameter(cm): 0.16cm; Exposure time(seconds): 5 to 10 min (mean of 9.18 min); Anatomic locations: On painful area Control group: Sham irradiation with a deactivated laser radiation, but the electrical circuit, timer and alarm worked as usual and controlled by a locked remote centralised computer
Outcomes	Measurements by: a blinded therapist ; Measured variables: pain graded as exacerbation, little or no change, fair, good, excellent; Follow up sessions: immediately and one day after treatment; Intention-to-treat analysis: no
Notes	Total score: 9
Allocation concealment	A – Adequate

Characteristics of excluded studies

Study	Reason for exclusion
Bertocco 2002	No LLLT group
Gale 2006	no LLLT group. Infrared therapy
Gallacchi 1981	no clinically important outcomes reported.
Georgiev 1996	Radiculopathy, low-back pain caused by specific pathological entities
Grabowski 1981	Not RCT or CCT
Gurtler 1979	Not RCT or CCT
Kou 1991	Laser acupuncture
Kreczi 1986	No separate analysis for Low back pain
Mika 1990	Not RCT or CCT
Ohshiro 1992	Not RCT or CCT
Okamoto 1989	No separate analysis for Low back pain
Pashnev 1991	Radiculopathy, low-back pain caused by specific pathological entities. No separate analysis for Low back pain
Snyder 1986	No separate analysis for Low back pain
Snyder 1989	No separate analysis for Low back pain
Tasaki 1991	Not RCT or CCT
Zati 2004	High power laser, Disc displacement

ADDITIONAL TABLES

Table 01. Search strategy for MEDLINE & CINAHL

1.randomized controlled trial.pt.
2.controlled clinical trial.pt
3.Randomized Controlled Trials/
4.Random Allocation/
5.Double-Blind Method/
6.Single-Blind Method/
7.or/1-6
8.Animal/ not Human/
9.7 not 8
10.clinical trial.pt.
11.exp Clinical Trials/
12.(clin$ adj25 trial$).tw.
13.((singl$ or doubl$ or trebl$ or tripl$) adj25 (blind$ or mask$)).tw.
14.Placebos/
15.placebo$.tw.
16.random$.tw.
17.Research Design/
18.(latin adj square).tw.
19. or/10-18
20.19 not 18

Table 01. Search strategy for MEDLINE & CINAHL (*Continued*)

21.20 not 9
22.Comparative Study/
23.exp Evaluation Studies/
24.Follow-Up Studies/
25.Prospective Studies?
26.(control$ or prospective$ or Volunteer$).tw.
27.Cross-Over Studies/
28.or/22-27
29.28 not 8
30.29 not (9 or 21)
31.9 or 21 or 30
32. back pain.sh
33. low back pain.sh
34. back pain.ti,ab
35. backache.ti,ab
36. exp back pain/
37. dorsalgia.ti,ab
38. lumbago.ti,ab
39. (lumbar adj pain).ti,ab
40.or/32-39
41. laser$.sh
42. laser$.tw
43. exp light/
44. infrared.tw
45. ultraviolet.tw
46. monochromatic.tw
47.or/41-46
48.31 and 40 and 47

Table 02. Criteria for internal validity

Criteria

A Was the method of randomization adequate? A random (unpredictable) assignment sequence.
B Was the treatment allocation concealed? Assignment generated by an independent person not responsible for determining the eligibility of the patients. This person has no information about the persons included in the trial and has no influence on the assignment sequence or on the decision about eligibility of the patient.
C Were the groups similar at baseline regarding the most important prognostic indicators? In order to receive a "yes", groups have to be similar at baseline characteristics.
D Was the patient blinded to the intervention? The reviewer determines if enough information about the blinding is given in order to score a "yes."
E Was the care provider blinded to the intervention? The reviewer determines if enough information about the blinding is given in order to score a "yes."
F Was the outcome assessor blinded to the intervention? The reviewer determines if enough information about the blinding is given in order to score a "yes."
G Were co-interventions avoided or similar? Co-interventions should either be avoided in the trial design or similar between the index and control groups.
H Was the compliance acceptable in all groups? The reviewer determines if the compliance to the interventions is acceptable.
I Was the drop-out rate described and acceptable? The number of participants who were included in the study but did not complete the observation period or were not included in the analysis must be described and reasons given. If the percentage of withdrawals and

Table 02. Criteria for internal validity (*Continued*)

Criteria
drop-outs does not exceed 20% for short-term follow-up and 30% for long-term follow-up and does not lead to substantial bias a "yes" is scored.
J Was the timing of the outcome assessment in all groups similar? Timing of outcome assessment should be identical for all intervention groups and for all important outcome assessments.
K Did the analysis include an intention-to-treat analysis? All randomized patients are reported/analyzed in the group they were allocated to by randomization for the most important moments of effect measurement (minus missing values) irrespective of noncompliance and co-interventions.

Table 03. Quality assessment of included studies

Name of study	Randomisation	Conc. of allocation	Baseline assessments	Blinding	Co-intervention	Compliance	Drop-out rates	Outcome assessment	Total score
Basford 1999	Adequate	No	No	Patients, providers, assessors	Avoided	Acceptable	Acceptable	similar timing: +; intention-to-treat: -	8
Gur 2003	inadequate information	No	Yes	assessors	Avoided	Acceptable	Acceptable	similar timing: +; intention-to-treat: -	6
Klein 1990	Adequate	Yes	Yes	Patients, providers, assessors	Avoided	Acceptable	Acceptable	similar timing: +; intention-to-treat: +	11
Longo 1991	inadequate information	Unclear	Unclear	Patients, providers, assessors	Avoided	Acceptable	Acceptable	similar timing: +; intention-to-treat: -	7
Soriano 1998	inadequate information	No	Yes	Patients, providers	Avoided	Acceptable	More than 20% in Control group	similar timing: +; intention-to-treat: -	6
Toya 1994	Adequate	Yes	Unclear	Patients, providers, assessors	Avoided	Acceptable	Acceptable	similar timing: +; intention-to-treat: -	9

Table 04. Laser dosing and characteristics of included studies

Name of study	Laser medium	Wave length (nm)	Laser mode	Output power	Power density	Dose (J/point)	Adequacy (WALT)
Basford 1999	Nd-YAG	1060	Continuous	1626 mW	542 mW/cm2	48.8J	Yes
Gur 2003	Gallium-	Not stated	Pulsed, 2.1	peak power	4.4 mW/cm2	1 J	No

Table 04. Laser dosing and characteristics of included studies (*Continued*)

Name of study	Laser medium	Wave length (nm)	Laser mode	Output power	Power density	Dose (J/point)	Adequacy (WALT)
	Arsenide		kHz pulse frequency	10W			
Klein 1990	Gallium-Arsenide	904	Pulsed, 1 kHz pulse frequency, 200 nsec pulse duration	peak power 2W	0.4 mW/cm2	0.1 J	No
Longo 1991	Gallium-Arsenide	904	Pulsed, 3 kHz pulse frequency, 200 nsec pulse duration	peak power 72W (27W?)	10 mW/cm2	3 J	No
Soriano 1998	Gallium-Arsenide	904	Pulsed, 10 kHz pulse frequency, 200 nsec pulse duration	peak power 20W	40 mW/cm2	4 J	Yes
Toya 1994	Ga-Al-As	830	continuous	60 mW	3000 mW/cm2	18-36 J	Yes

ANALYSES

Comparison 01. LLLT versus sham intervention (grouping based on follow-up durations)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Pain (VAS)	3	126	Weighted Mean Difference (Fixed) 95% CI	-11.33 [-16.91, -5.75]
02 Low back pain related disability	3	126	Standardised Mean Difference (Random) 95% CI	-0.14 [-0.88, 0.59]
03 Range of motion (Anterior-posterior flexion)	3	126	Standardised Mean Difference (Fixed) 95% CI	0.01 [-0.34, 0.36]
05 Relapse			Relative Risk (Random) 95% CI	Subtotals only

Comparison 02. LLLT versus sham intervention (grouping based on laser dosing)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Pain(VAS)-short term follow-up	3	126	Weighted Mean Difference (Fixed) 95% CI	-11.33 [-16.91, -5.75]
02 Low back pain related disability-Short term follow-up	3	126	Standardised Mean Difference (Random) 95% CI	-0.14 [-0.88, 0.59]
03 Range of motion-short term follow-up	3	126	Standardised Mean Difference (Fixed) 95% CI	0.01 [-0.34, 0.36]

04 Relapse-Intermediate term follow-up	2	151	Relative Risk (Random) 95% CI	0.43 [0.28, 0.65]

Comparison 03. LLLT versus sham intervention (grouping based on the presence of exercise therapy)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Pain (VAS)	3	126	Weighted Mean Difference (Fixed) 95% CI	-11.33 [-16.91, -5.75]
02 Low back pain related disability	3	126	Standardised Mean Difference (Random) 95% CI	-0.14 [-0.88, 0.59]
03 Range of motion (Anterior-posterior flexion)	3	126	Standardised Mean Difference (Fixed) 95% CI	0.01 [-0.34, 0.36]

COVER SHEET

Title	Low level laser therapy for nonspecific low-back pain
Authors	Yousefi-Nooraie R, Schonstein E, Heidari K, Rashidian A, Akbari-Kamrani M, Irani S, Shakiba B, Mortaz Hejri Sa, Mortaz Hejri So, Jonaidi A
Contribution of author(s)	Yousefi-Nooraie R, Schonstein E, Heidari K, Rashidian A, Akbari Kamrani M, Irani S, Shakiba B, Mortaz Hejri Sa, Mortaz Hejri So, Jonaidi A, conceptualization of topic and registration of title: Yousefi-Nooraie R, Schonstein E, Heidari K, Rashidian A, Akbari Kamrani M, Irani S, Shakiba B, Mortaz Hejri Sa, Mortaz Hejri So, Jonaidi A development of review team:Yousefi-Nooraie R development of protocol:Yousefi-Nooraie R, Schonstein E, Heidari K, Akbari Kamrani M, Irani S, Shakiba B, Mortaz Hejri Sa, Mortaz Hejri So, Rashidian A, Jonaidi A literature search: Yousefi-Nooraie R, Schonstein E, Heidari K, Shakiba B selection of trials: Yousefi-Nooraie R, Schonstein E quality assessment of trials: Mortaz Hejri Sa, Akbari Kamrani M, Heidari K, Shakiba B data extraction: Yousefi-Nooraie R, Akbari Kamrani M, Irani S data analysis: Yousefi-Nooraie R, Akbari Kamrani M interpretation of results: Yousefi-Nooraie R, Schonstein E, Heidari K, Rashidian A, Akbari Kamrani M, Irani S, Shakiba B, Mortaz Hejri Sa, Mortaz Hejri So, Jonaidi A writing of review: Yousefi-Nooraie R, Rashidian A, Schonstein E, Heidari K, Akbari Kamrani M, Irani S, Shakiba B, Mortaz Hejri Sa, Mortaz Hejri So, Jonaidi A review of final manuscripts of protocol and review: Yousefi-Nooraie R, Rashidian A, Schonstein E, Heidari K, Akbari Kamrani M, Irani S, Shakiba B, Mortaz Hejri Sa, Mortaz Hejri So, Jonaidi A
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What's New	Information not supplied by author
Date new studies sought but none found	Information not supplied by author
Date new studies found but not yet included/excluded	Information not supplied by author

Date new studies found and included/excluded	12 January 2007
Date authors' conclusions section amended	Information not supplied by author
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GRAPHS AND OTHER TABLES

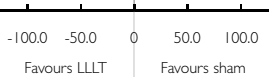
Analysis 01.01. Comparison 01 LLLT versus sham intervention (grouping based on follow-up durations), Outcome 01 Pain (VAS)

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 01 LLLT versus sham intervention (grouping based on follow-up durations)

Outcome: 01 Pain (VAS)

Study	LLLT N	LLLT Mean(SD)	Control N	Control Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weight (%)	Weighted Mean Difference (Fixed) 95% CI
01 Short term follow up (less than 3 months after randomization)							
Basford 1999	27	19.10 (22.80)	29	35.10 (22.80)		21.8	-16.00 [-27.95, -4.05]
Gur 2003	25	18.00 (12.00)	25	29.00 (13.00)		64.8	-11.00 [-17.94, -4.06]
Klein 1990	10	22.66 (18.66)	10	28.00 (16.00)		13.4	-5.34 [-20.57, 9.89]
Subtotal (95% CI)	62		64			100.0	-11.33 [-16.91, -5.75]
Test for heterogeneity chi-square=1.19 df=2 p=0.55 I^2 =0.0%							
Test for overall effect z=3.98 p=0.00007							
02 Intermediate-term follow up (3 months to 1 year)							
Subtotal (95% CI)	0		0			0.0	Not estimable
Test for heterogeneity: not applicable							
Test for overall effect: not applicable							



(*Continued* . . .)

(... *Continued*)

Study	LLLT N	LLLT Mean(SD)	Control N	Control Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weight (%)	Weighted Mean Difference (Fixed) 95% CI
03 Long-term follow up (longer than one year)							
Subtotal (95% CI)	0		0			0.0	Not estimable
Test for heterogeneity: not applicable							
Test for overall effect: not applicable							
Total (95% CI)	62		64			100.0	-11.33 [-16.91, -5.75]
Test for heterogeneity chi-square=1.19 df=2 p=0.55 I^2 =0.0%							
Test for overall effect z=3.98 p=0.00007							

-100.0 -50.0 0 50.0 100.0
Favours LLLT Favours sham

Analysis 01.02. Comparison 01 LLLT versus sham intervention (grouping based on follow-up durations), Outcome 02 Low back pain related disability

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 01 LLLT versus sham intervention (grouping based on follow-up durations)

Outcome: 02 Low back pain related disability

Study	LLLT N	LLLT Mean(SD)	Control N	Control Mean(SD)	Standardised Mean Difference (Random) 95% CI	Weight (%)	Standardised Mean Difference (Random) 95% CI
01 Short term follow up (less than 3 months after randomization)							
Basford 1999	27	14.70 (10.00)	29	22.90 (10.00)		36.4	-0.81 [-1.36, -0.26]
Gur 2003	25	14.80 (8.60)	25	13.60 (7.20)		36.2	0.15 [-0.41, 0.70]
Klein 1990	10	3.60 (2.10)	10	2.90 (1.60)		27.4	0.36 [-0.53, 1.24]
Subtotal (95% CI)	62		64			100.0	-0.14 [-0.88, 0.59]
Test for heterogeneity chi-square=7.79 df=2 p=0.02 I^2 =74.3%							
Test for overall effect z=0.38 p=0.7							
02 Intermediate-term follow up (3 months to 1 year)							
Subtotal (95% CI)	0		0			0.0	Not estimable
Test for heterogeneity: not applicable							
Test for overall effect: not applicable							
03 Long-term follow up (longer than one year)							
Subtotal (95% CI)	0		0			0.0	Not estimable
Test for heterogeneity: not applicable							
Test for overall effect: not applicable							
Total (95% CI)	62		64			100.0	-0.14 [-0.88, 0.59]
Test for heterogeneity chi-square=7.79 df=2 p=0.02 I^2 =74.3%							
Test for overall effect z=0.38 p=0.7							

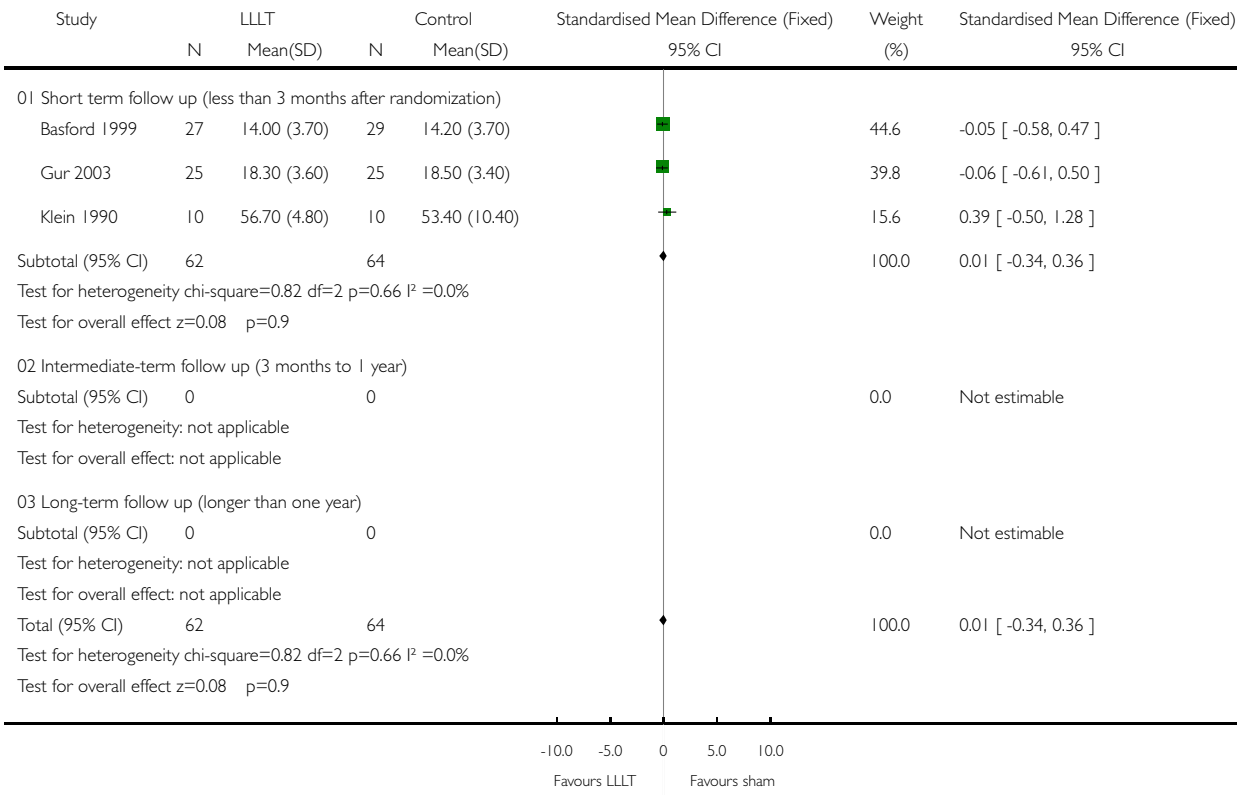
-10.0 -5.0 0 5.0 10.0
Favours LLLT Favours sham

Analysis 01.03. Comparison 01 LLLT versus sham intervention (grouping based on follow-up durations), Outcome 03 Range of motion (Anterior-posterior flexion)

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 01 LLLT versus sham intervention (grouping based on follow-up durations)

Outcome: 03 Range of motion (Anterior-posterior flexion)



Analysis 01.05. Comparison 01 LLLT versus sham intervention (grouping based on follow-up durations), Outcome 05 Relapse

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 01 LLLT versus sham intervention (grouping based on follow-up durations)

Outcome: 05 Relapse

Study	LLLT n/N	Control n/N	Relative Risk (Random) 95% CI	Weight (%)	Relative Risk (Random) 95% CI
01 Short term follow up (less than 3 months after randomization)					
Longo 1991	0/40	5/40		100.0	0.09 [0.01, 1.59]
Subtotal (95% CI)	40	40		100.0	0.09 [0.01, 1.59]
Total events: 0 (LLLT), 5 (Control)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.64 p=0.1					
02 Intermediate-term follow up (3 months to 1 year)					
Longo 1991	12/40	35/40		49.0	0.34 [0.21, 0.56]
Soriano 1998	14/38	23/33		51.0	0.53 [0.33, 0.85]
Subtotal (95% CI)	78	73		100.0	0.43 [0.28, 0.65]
Total events: 26 (LLLT), 58 (Control)					
Test for heterogeneity chi-square=1.57 df=1 p=0.21 I^2 =36.5%					
Test for overall effect z=3.91 p=0.00009					
03 Long-term follow up (longer than one year)					
Longo 1991	26/40	38/40		100.0	0.68 [0.54, 0.87]
Subtotal (95% CI)	40	40		100.0	0.68 [0.54, 0.87]
Total events: 26 (LLLT), 38 (Control)					
Test for heterogeneity: not applicable					
Test for overall effect z=3.12 p=0.002					

Analysis 02.01. Comparison 02 LLLT versus sham intervention (grouping based on laser dosing), Outcome 01 Pain(VAS)-short term follow-up

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 02 LLLT versus sham intervention (grouping based on laser dosing)

Outcome: 01 Pain(VAS)-short term follow-up

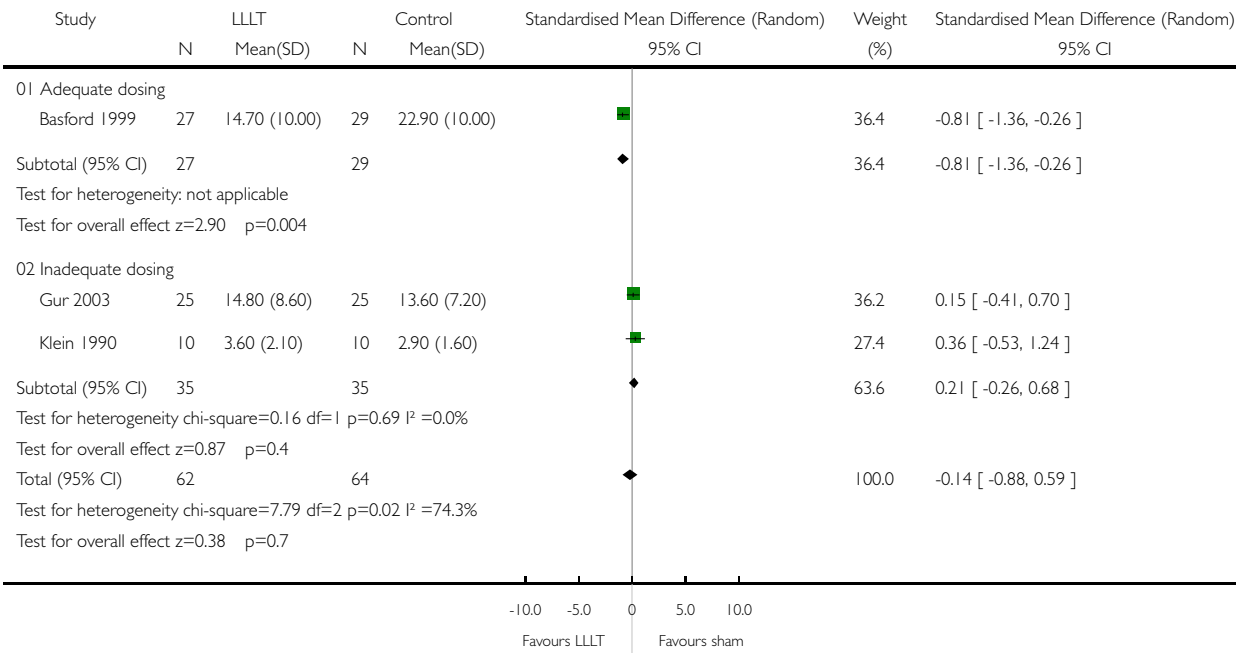
Study	LLLT N	LLLT Mean(SD)	Control N	Control Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weight (%)	Weighted Mean Difference (Fixed) 95% CI
01 Adequate dosing							
Basford 1999	27	19.10 (22.80)	29	35.10 (22.80)		21.8	-16.00 [-27.95, -4.05]
Subtotal (95% CI)	27		29			21.8	-16.00 [-27.95, -4.05]
Test for heterogeneity: not applicable							
Test for overall effect z=2.62 p=0.009							
02 Inadequate dosing							
Gur 2003	25	18.00 (12.00)	25	29.00 (13.00)		64.8	-11.00 [-17.94, -4.06]
Klein 1990	10	22.66 (18.66)	10	28.00 (16.00)		13.4	-5.34 [-20.57, 9.89]
Subtotal (95% CI)	35		35			78.2	-10.03 [-16.34, -3.72]
Test for heterogeneity chi-square=0.44 df=1 p=0.51 I^2 =0.0%							
Test for overall effect z=3.11 p=0.002							
Total (95% CI)	62		64			100.0	-11.33 [-16.91, -5.75]
Test for heterogeneity chi-square=1.19 df=2 p=0.55 I^2 =0.0%							
Test for overall effect z=3.98 p=0.00007							

Analysis 02.02. Comparison 02 LLLT versus sham intervention (grouping based on laser dosing), Outcome 02 Low back pain related disability-Short term follow-up

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 02 LLLT versus sham intervention (grouping based on laser dosing)

Outcome: 02 Low back pain related disability-Short term follow-up



Analysis 02.03. Comparison 02 LLLT versus sham intervention (grouping based on laser dosing), Outcome 03 Range of motion-short term follow-up

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 02 LLLT versus sham intervention (grouping based on laser dosing)

Outcome: 03 Range of motion-short term follow-up

Study	LLLT N	LLLT Mean(SD)	Control N	Control Mean(SD)	Standardised Mean Difference (Fixed) 95% CI	Weight (%)	Standardised Mean Difference (Fixed) 95% CI
01 Adequate dosing							
Basford 1999	27	14.00 (3.70)	29	14.20 (3.70)		44.6	-0.05 [-0.58, 0.47]
Subtotal (95% CI)	27		29			44.6	-0.05 [-0.58, 0.47]
Test for heterogeneity: not applicable							
Test for overall effect z=0.20 p=0.8							
02 Inadequate dosing							
Gur 2003	25	18.30 (3.60)	25	18.50 (3.40)		39.8	-0.06 [-0.61, 0.50]
Klein 1990	10	56.70 (4.80)	10	53.40 (10.40)		15.6	0.39 [-0.50, 1.28]
Subtotal (95% CI)	35		35			55.4	0.07 [-0.40, 0.54]
Test for heterogeneity chi-square=0.70 df=1 p=0.40 I^2 =0.0%							
Test for overall effect z=0.29 p=0.8							
Total (95% CI)	62		64			100.0	0.01 [-0.34, 0.36]
Test for heterogeneity chi-square=0.82 df=2 p=0.66 I^2 =0.0%							
Test for overall effect z=0.08 p=0.9							

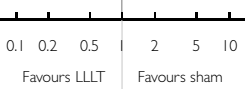
Analysis 02.04. Comparison 02 LLLT versus sham intervention (grouping based on laser dosing), Outcome 04 Relapse-Intermediate term follow-up

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 02 LLLT versus sham intervention (grouping based on laser dosing)

Outcome: 04 Relapse-Intermediate term follow-up

Study	LLLT n/N	Control n/N	Relative Risk (Random) 95% CI	Weight (%)	Relative Risk (Random) 95% CI
01 Adequate dosing					
Soriano 1998	14/38	23/33		51.0	0.53 [0.33, 0.85]
Subtotal (95% CI)	38	33		51.0	0.53 [0.33, 0.85]
Total events: 14 (LLLT), 23 (Control)					
Test for heterogeneity: not applicable					
Test for overall effect z=2.64 p=0.008					
02 Inadequate dosing					
Longo 1991	12/40	35/40		49.0	0.34 [0.21, 0.56]
Subtotal (95% CI)	40	40		49.0	0.34 [0.21, 0.56]
Total events: 12 (LLLT), 35 (Control)					
Test for heterogeneity: not applicable					
Test for overall effect z=4.30 p=0.00002					
Total (95% CI)	78	73		100.0	0.43 [0.28, 0.65]
Total events: 26 (LLLT), 58 (Control)					
Test for heterogeneity chi-square=1.57 df=1 p=0.21 I^2 =36.5%					
Test for overall effect z=3.91 p=0.00009					



Analysis 03.01. Comparison 03 LLLT versus sham intervention (grouping based on the presence of exercise therapy), Outcome 01 Pain (VAS)

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 03 LLLT versus sham intervention (grouping based on the presence of exercise therapy)

Outcome: 01 Pain (VAS)

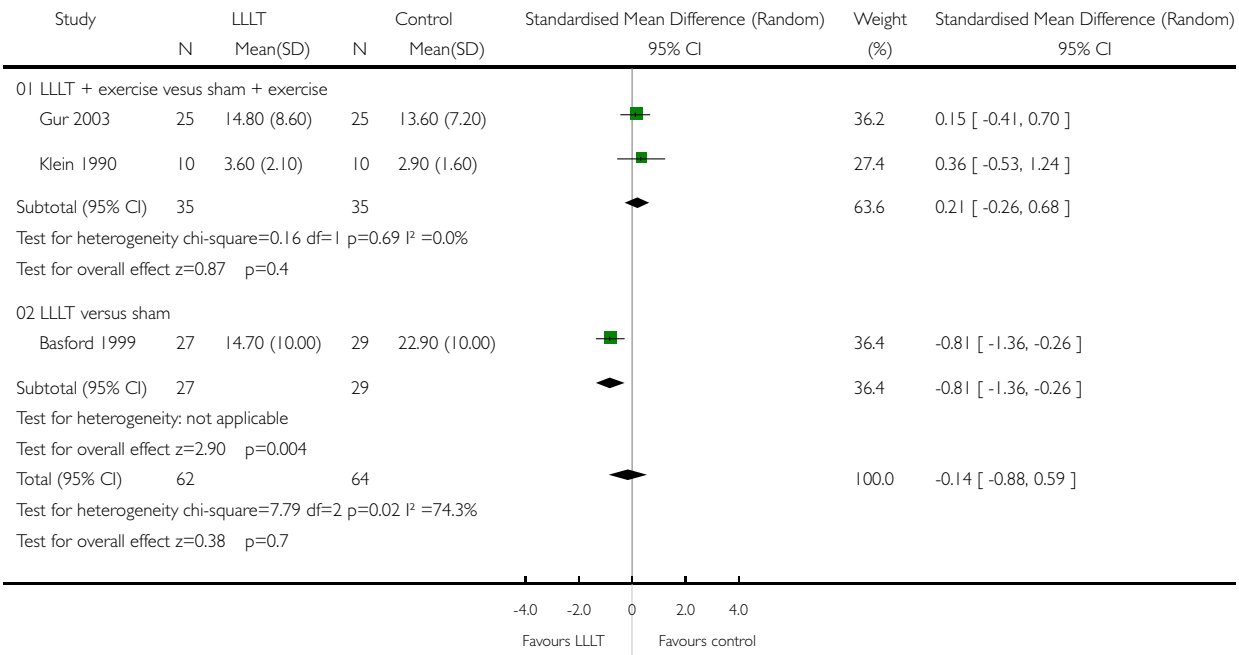
Study	LLLT		Control		Weighted Mean Difference (Fixed)	Weight	Weighted Mean Difference (Fixed)
	N	Mean(SD)	N	Mean(SD)	95% CI	(%)	95% CI
01 LLLT + exercise versus sham + exercise							
Gur 2003	25	18.00 (12.00)	25	29.00 (13.00)		64.8	-11.00 [-17.94, -4.06]
Klein 1990	10	22.66 (18.66)	10	28.00 (16.00)		13.4	-5.34 [-20.57, 9.89]
Subtotal (95% CI)	35		35			78.2	-10.03 [-16.34, -3.72]
Test for heterogeneity chi-square=0.44 df=1 p=0.51 I^2 =0.0%							
Test for overall effect z=3.11 p=0.002							
02 LLLT versus sham							
Basford 1999	27	19.10 (22.80)	29	35.10 (22.80)		21.8	-16.00 [-27.95, -4.05]
Subtotal (95% CI)	27		29			21.8	-16.00 [-27.95, -4.05]
Test for heterogeneity: not applicable							
Test for overall effect z=2.62 p=0.009							
Total (95% CI)	62		64			100.0	-11.33 [-16.91, -5.75]
Test for heterogeneity chi-square=1.19 df=2 p=0.55 I^2 =0.0%							
Test for overall effect z=3.98 p=0.00007							

Analysis 03.02. Comparison 03 LLLT versus sham intervention (grouping based on the presence of exercise therapy), Outcome 02 Low back pain related disability

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 03 LLLT versus sham intervention (grouping based on the presence of exercise therapy)

Outcome: 02 Low back pain related disability



Analysis 03.03. Comparison 03 LLLT versus sham intervention (grouping based on the presence of exercise therapy), Outcome 03 Range of motion (Anterior-posterior flexion)

Review: Low level laser therapy for nonspecific low-back pain

Comparison: 03 LLLT versus sham intervention (grouping based on the presence of exercise therapy)

Outcome: 03 Range of motion (Anterior-posterior flexion)

Study	LLLT N	LLLT Mean(SD)	Control N	Control Mean(SD)	Standardised Mean Difference (Fixed) 95% CI	Weight (%)	Standardised Mean Difference (Fixed) 95% CI
01 LLLT + exercise versus sham + exercise							
Gur 2003	25	18.30 (3.60)	25	18.50 (3.40)		39.8	-0.06 [-0.61, 0.50]
Klein 1990	10	56.70 (4.80)	10	53.40 (10.40)		15.6	0.39 [-0.50, 1.28]
Subtotal (95% CI)	35		35			55.4	0.07 [-0.40, 0.54]
Test for heterogeneity chi-square=0.70 df=1 p=0.40 I^2 =0.0%							
Test for overall effect z=0.29 p=0.8							
02 LLLT versus sham							
Basford 1999	27	14.00 (3.70)	29	14.20 (3.70)		44.6	-0.05 [-0.58, 0.47]
Subtotal (95% CI)	27		29			44.6	-0.05 [-0.58, 0.47]
Test for heterogeneity: not applicable							
Test for overall effect z=0.20 p=0.8							
Total (95% CI)	62		64			100.0	0.01 [-0.34, 0.36]
Test for heterogeneity chi-square=0.82 df=2 p=0.66 I^2 =0.0%							
Test for overall effect z=0.08 p=0.9