VU Research Portal

The Efficacy of Laser Therapy for Musculoskeletal and Skin Disorders - A Criteria-Based Metaanalysis of Randomized Clinical-Trials

Beckerman, H.; Debie, R.A.; Bouter, L.M.; de Cuyper, H.J.; Oostendorp, R.A.B.

published in

Physical Therapy
1992

document version

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Beckerman, H., Debie, R. A., Bouter, L. M., de Cuyper, H. J., & Oostendorp, R. A. B. (1992). The Efficacy of Laser Therapy for Musculoskeletal and Skin Disorders - A Criteria-Based Metaanalysis of Randomized Clinical-Trials. *Physical Therapy*, 72(7), 483-491.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:

vuresearchportal.ub@vu.nl

The Efficacy of Laser Therapy for Musculoskeletal and Skin Disorders: A Criteria-Based Meta-analysis of Randomized Clinical Trials

*The efficacy of laser therapy for musculoskeletal and skin disorders has been assessed on the basis of the results of 36 randomized clinical trials (RCTs) involving 1,704 patients. For this purpose, a criteria-based meta-analysis that took into account the methodological quality of the individual trials was used. The studies with a positive outcome were generally of a better quality than the studies with a negative outcome. No clear relationship could be demonstrated between the laser dosage applied and the efficacy of laser therapy, or between the dosage and the methodological score. In general, the methodological quality of these studies appeared to be rather low. Consequently, no definite conclusions can be drawn about the efficacy of laser therapy for skin disorders. The efficacy of laser therapy for musculoskeletal disorders seems, on average, to be larger than the efficacy of a placebo treatment. More specifically, for rheumatoid arthritis, posttraumatic joint disorders, and myofascial pain, laser therapy seems to have a substantial specific therapeutic effect. Further RCTs, avoiding the most prevalent methodological errors, are needed in order to enable the benefits of laser therapy to be more precisely and validly evaluated. [Beckerman H, de Bie RA, Bouter LM, et al. The efficacy of laser therapy for musculoskeletal and skin disorders: a criteria-based meta-analysis of randomized clinical trials. *Phys Ther.* 1992;72:483-491.]*

Key Words: *Laser therapy, Meta-analysis, Physical therapy, Randomized clinical trials, Review.*

**Heleen Beckerman
Rob A de Bie
Lex M Bouter
Hugo J De Cuyper
Rob AB Oostendorp**

H Beckerman, PT, is Research Associate, Department of Rehabilitation Medicine, Free University Hospital, PO Box 7057, 1007 MB Amsterdam, the Netherlands. Address correspondence to Ms Beckerman.

RA de Bie, PT, is Research Associate, Department of Epidemiology and Biostatistics, University of Limburg, Maastricht, the Netherlands.

LM Bouter, PhD, is Professor of Epidemiology, Free University, Institute for Extramural Medical Research, Amsterdam, the Netherlands.

HJ De Cuyper, MD, is Director, Department of Physical Therapy, Gallifort Hospital, Antwerp, Belgium.

RAB Oostendorp, PhD, PT, is Research Director, Dutch Foundation for Research and Postgraduate Education in Physical Therapy, Amersfoort, the Netherlands, and Professor of Biomedical Science/Manual Therapy, Free University of Brussels, Brussels, Belgium.

This study was supported by a grant from the Dutch Ministry of Welfare, Public Health, and Cultural Affairs (Project 89-42).

This article was submitted June 7, 1991, and was accepted February 24, 1992.

Recently, laser therapy has become a popular modality, at least in some countries, in the physical therapy management of musculoskeletal and skin disorders.^{1,2} The lasers used by physical therapists are the "soft" and "mid" lasers with an athermic effect. Frequently used lasers include the helium-neon laser (He-Ne gas) and infrared lasers (with the diode gallium-arsenide [Ga-As] or gallium-aluminum-arsenide [Ga-Al-As]), or combinations of both types.³

To assess the efficacy of laser therapy, we conducted a review of reported studies that used randomized clinical trials (RCTs) in order to seek answers

to two questions: (1) Is laser therapy more effective than placebo laser therapy? and (2) Is laser therapy more effective than other (eg, physical therapy) treatments?

During the past 10 years, a number of authors^{4,5} have postulated the biostimulative effects of low-level laser therapy. *Biostimulation*, or *laser-catalyzed reactions*, refers to the application of electromagnetic energy by low-level laser therapy to body tissues, which is supposed to lead to the stimulation of all kinds of cell functions.^{6,7} The effects are thought to consist of stimulation or inhibition of biochemical, physiological, and proliferative activities. The magnitude of this effect seems to depend on the wavelength and dosage of the laser light.⁶ It has long been known that cells are sensitive to specific wavelengths.⁸ Cells in cultures can communicate with each other by means of electromagnetic energy, which influences metabolic and catabolic cell processes.⁸ In the event of an impairment or disorder, the energy state of a cell is changed, consequently altering the accompanying communication. Laser therapy is thought to influence this communication.

Photochemical theory offers an alternative explanation for the sensitivity of cells to laser light.^{6,7} According to this theory, the absorption of laser light takes place in tissue chromophores (photoacceptors). These chromophores may be an enzyme, a membrane molecule, or any other cellular or extracellular substance. Activation of these chromophores by laser light is thought to be responsible for the postulated biostimulative effects. Currently, however, there is no universally accepted theory that explains the mechanism of the postulated laser effects.³⁻⁵

This article will focus on the clinical evidence for the efficacy of laser therapy from RCTs. For this purpose, a full understanding of the mechanisms involved is not necessary, although the current lack of knowledge can complicate the interpretation of conflicting results from these RCTs.

To assess the efficacy of laser therapy for the management of musculoskeletal disorders and skin disorders, a criteria-based meta-analysis was conducted. *Meta-analysis* refers to a critical summary of the evidence on the efficacy of an intervention based on the available reports of RCTs on the topic.^{9,10}

We decided to use only RCTs in our meta-analysis because the RCT is the best study design for obtaining a reliable evaluation of treatment effect on patients with minimal threats to validity.¹¹⁻¹⁴ Nevertheless, RCTs also can substantially vary in methodological quality. Inclusion of all available RCTs in a review, not taking into account the validity of the trial, can introduce a substantial amount of information bias, leading to overestimation or underestimation of the efficacy of the treatment at issue.¹¹ Examples of these biased results are provided by recent criteria-based meta-analyses.¹⁵⁻¹⁷ Therefore, we decided to focus on the methodological quality of the studies. In this way, conclusions about the efficacy of laser therapy can be drawn from the best methodological studies only.

Method

Literature Search

Articles reporting the results of RCTs were found by various strategies. Computer searches were carried out (MEDLINE for the period 1966-1990, EXCERPTA MEDICA for the period 1974-1990), using as key words "lasers," "musculoskeletal diseases," "wound healing," "skin ulcer," "pain," "acupuncture," "therapeutic use," "adverse effects," and "human." Articles with the key words "surgery," "neoplasms," or "hyperthermia" were excluded. Trials published in any language were eligible. Eighteen of the publications included in this meta-analysis were found this way. A literature search using the physical therapy database of the Dutch Foundation for Research and Postgraduate Education in Physical Therapy identified another 3 articles. The 15 other articles were found by checking references in arti-

cles and textbooks, by checking the proceedings of conferences on the uses of lasers, and by personal communication with researchers in the field.

To be included in the meta-analysis, the studies had to meet the following criteria:

1. Intervention: the study had to deal with the efficacy of laser therapy compared with the efficacy of a placebo laser treatment, a sham laser treatment, or other therapies.
2. Study design: only RCTs were selected.
3. Study population: only studies including patients with disorders of the musculoskeletal system or skin disorders that were an indication for physical therapy were eligible.
4. Outcome measures: these measures should be clinically important for the problem at issue.

Methodological Criteria

The essential feature of a criteria-based meta-analysis is an assessment of the methodological quality (internal validity) of the RCTs. An RCT is internally valid if the differences in outcome between the investigated groups are indeed caused by the differences in treatment. Standards for the conduct and reporting of RCTs, generally recognized as the strongest study design, have been widely published.¹⁰⁻¹³ For this assessment, we used a list of 24 criteria dealing with the study population, measurement of effect, description of the therapeutic regimens, and data analysis and presentation of the results (see key to Tab. 1; full description is available from the authors on request). A study could earn points on each criterion, with a maximum score of 25 points. Similar criteria have been used in other meta-analyses.¹⁵⁻¹⁸

Study Assessment

Two reviewers (HB and RAdB), independently of each other, applied

Table 1. Scores for Methodological Characteristics of Randomized Clinical Trials of Laser Therapy

Reference	Criterion ^a																				Total ^b				
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T		U	V	W	X
Articles																									
Basford et al, ¹⁹ 1987	1	1	2	1	1	1	1	1	1	1		1	1	1	1	1	1		1		1		−1		18
de Bie et al, ²¹ 1989			2	1	1	1	1	1	1	1	1	1	1	1					1	1	1		−1		15
Gudmundsen and colleagues, ^{32,34} 1987, 1989		3	2	1		1	1			1	1	1			1	1			1	1	1	−1			15
Haker and Lundeborg, ³³ 1990			2	1	1	1	1		1	1	1	1		1	1		1	1	1	1	1	−1	−1		15
Walker et al, ⁵² 1987	1		2	1	1	1	1	1	1			1	2	1					1		1				15
Ceccherelli et al, ²⁴ 1989			2	1	1	1	1			1	1		2	1	1				1		1				14
Walker et al, ⁵³ 1987			2	1	1	1	1	1				1	2	1					1		1				13
Klein and Eek, ³⁶ 1990	1				1	1	1	1	1	1	1	1	2				1		1				−1		12
Bliddal et al, ²³ 1987			2	1	1					1		1		1	1		1		1	1	1	−1			11
Kreczi and Klingler, ³⁷ 1986			2	1			1			1		1	1	1			1		1	1	1	−1			11
Lundeborg et al, ³⁸ 1987			2	1	1	1	1			1		1		1	1				1	1			−1		11
Siebert et al, ⁴⁷ 1987	1		2	1		1	1			1		1			1				1	1	1		−1		11
Palmgren et al, ⁴⁴ 1989			2	1	1	1		1	1	1	1		1					1	1		1	−1	−1		11
Snyder-Mackler et al, ⁴⁸ 1986			1		1				1	1	1		2	1			1		1	1					11
Flöter and Rehfisch, ^c 1988	2		1							1		1	1	1			1		1	1	1			−1	10
Jensen et al, ³⁵ 1987	1		2	1	1		1			1		1		1					1		1		−1		10
Moore et al, ⁴² 1988			2	1	1		1			1	1	1	1	1					1		1	−1		−1	10
Gallachi and colleagues, ^{28,29} 1981			2	1			1			1		1							1	1	1				9
Snyder-Mackler et al, ⁴⁹ 1989			2	1						1			2	1					1	1					9
Crous and Malherbe, ²⁵ 1988			2	1		1						1	1	1					1						8
England et al, ²⁶ 1989			2	1						1		1	1						1		1				8
Walker, ⁵¹ 1985					1		1		1			1		1			1		1		1	−1			7
Bihari and Mester, ²² 1989			2		1		1			1		1			1				1			−1	−1		6
Meier and Kerkour, ⁴⁰ 1988	1				1		1			1	1			1							1	−1			6
Waylonis et al, ⁵⁴ 1988	2		1				1					1	1				1				1	−1	−1		6
Gobelet et al, ³¹ 1986			2	1						1	1			1								−1		−1	4
Tsurko et al, ⁵² 1983						1	1			1		1							1			−1			4
Santoianni et al, ⁴⁵ 1984							1						1	1					1		1	−1	−1		3
Falkenbach et al, ²⁷ 1987	1									1		1		1		1						−1	−1		2
Seichert et al, ⁴⁶ 1987							1			1				1						1	1	−1	−1	−1	2
Abstracts and brief reports																									
Gärtner et al, ³⁰ 1989	1	2			1	1	1	1	1	1		1					1				1	−1		−1	10
Miyagi, ⁴¹ 1989	1				1		1			1	1						1						−1		5
McAuley and Ysla, ³⁹ 1985	1				1					1	1			1									−1	−1	3
Nivbrant and Friberg, ⁴³ 1989					1					1	1				1								−1		3
Beard et al, ²⁰ 1990					1		1			1	1											−1	−1		2
Ysla and McAuley, ⁵⁵ 1985					1		1			1	1											−1	−1	−1	1

^aComparability of the groups: (A) randomization correct, (B) number of patients in the smallest group, (C) percentage of loss to follow-up $\leq 20\%$, (D) no selective loss to follow-up, (E) restriction to homogeneous groups, (F) relevant baseline characteristics described, (G) cointerventions similar in all groups, (H) comparability of prognosis between the groups, (I) correction for imbalance at baseline during analyses; comparability of effect measurement: (J) patients blinded, (K) therapist blinded, (L) evaluator blinded, (M) effect measurements relevant and well described, (N) effect measurements at relevant moments during the trial, (O) effect measurements after the treatment period (follow-up); extra points: (P) analysis blinded, (Q) adverse effects investigated, (R) intention-to-treat analysis, (S) frequencies of most important outcomes presented for each group, (T) laser therapy standardized and described, (U) other interventions standardized and described; minus point: (V) statistical analysis not correct, (W) power calculation not performed, (X) wash-out period (crossover design) too short. Full description of the criteria is available from the authors on request.

^bMaximum total score = 25 points.

^cTH Flöter, HP Rehfisch; unpublished report.

Table 2. *Characteristics and Results of the Seven Best Trials*

Reference	Methodological Score	Intervention ^a (No. of Patients)	Diagnosis	Outcomes in Each Group
Basford et al, ¹⁹ 1987	18	He-Ne laser (47), placebo laser (34)	osteoarthritis, thumb	after 9 treatments beneficial effect: 47%/44% change in range of motion: 0.2°/0.2° strength change: 1.9/1.8
de Bie et al, ²¹ 1989	15	IR laser and taping (12), placebo laser and taping (11), taping (15)	lateral ankle sprains	after 5 treatments (percentage of change) change in pain by day: 71%/48%/53% change in pain by night: 98%/76%/60% change in impairment of sports participation: 8%/0%/4% after 10 treatments (percentage of change) change in pain by day: 90%/78%/91% change in pain by night: 97%/95%/94% change in impairment of sport participation: 42%/37%/18%
Gudmundsen and colleagues, ^{32,34} 1987, 1989	15	IR laser (103), placebo He-Ne laser (97)	epicondylitis lateralis, rotator cuff syndrome	1 month after 2 weeks of treatment improvement: free of symptoms, 31%/3%; improved, 63%/29%; unchanged, 6%/60%; worse, 0%/8% change in sick leave: 68%/30%
Haker and Lundeborg, ³³ 1990	15	IR laser (23), placebo laser (26)	lateral humeral epicondylalgia	after 10 treatments improvement: excellent or good, 22%/46%; slightly improved, 22%/19%; unchanged, 26%/19%; worse, 26%/19% change in grip strength, 10 kPa/17 kPa
Walker et al, ⁵² 1987	15	He-Ne laser (38), placebo laser (34)	rheumatoid arthritis	after 30 treatments visual analogue scale (changes in millimeters): -13.7/-1.5
Ceccherelli et al, ²⁴ 1989	14	IR laser (13), placebo laser (26)	cervical myofascial pain	after 12 treatments McGill Pain Questionnaire: change in no. of words, -6.2/+0.2; change in total score, -16.3/-2.0 visual analogue scale (changes in millimeters): -37.2/+8.2
Walker et al, ⁵³ 1987	13	He-Ne laser (18), placebo laser (17)	trigeminal neuralgia	after 30 treatments pain intensity: no information other than results of statistical tests for each group painful episodes: no information other than results of statistical test for each group

^aHe-Ne=helium-neon, IR=infrared.

these criteria to each trial. Differences between the two reviewers, which were mainly caused by reading errors, unclear descriptions in the publications, or unclear descriptions of the criteria, were resolved by discussion and further clarification of the criteria.

Results

Thirty-six RCTs, involving a total of 1,704 patients with musculoskeletal or skin disorders, met the inclusion criteria (TH Flöter, HP Rehfisch; unpublished report; 1988).¹⁹⁻⁵⁵ Publications dealing with the same study (ie, refer-

ences 28 and 29 and references 32 and 34) were grouped together for the methodological assessment. This means that the study could earn points if information was presented in one or both articles. Table 1 presents the results of the meta-analysis, indi-

Table 3. *Clinical Trials of Laser Therapy Grouped According to Diagnosis*

Reference	Indication	Methodological Score	Result ^a
Joint disorders			
Basford et al, ¹⁹ 1987	osteoarthritis, thumb	18	negative
Walker et al, ⁵² 1987	rheumatoid arthritis	15	positive
de Bie et al, ²¹ 1989	lateral ankle sprain	15	positive
Klein and Eek, ³⁶ 1990	chronic low back pain	12	negative
Bliddal et al, ²³ 1987	rheumatoid arthritis, fingers	11	negative
Palmgren et al, ⁴⁴ 1989	rheumatoid arthritis, fingers	11	positive
Kreczi and Klingler, ³⁷ 1986	radicular and pseudoradicular pain syndromes	11	positive
Gärtner et al, ³⁰ 1989	ankylosing spondylitis	10	@
Jensen et al, ³⁵ 1987	gonarthrosis	10	negative
Miyagi, ⁴¹ 1989	rheumatoid arthritis, knee	5	positive
Tsurko et al, ⁵⁰ 1983	rheumatoid arthritis	4	@
McAuley and Ysla, ³⁹ 1985	osteoarthritis, knee	3	negative
Nivbrant and Friberg, ⁴³ 1989	gonarthrosis	3	positive
Beard et al, ²⁰ 1990	rheumatoid arthritis, fingers	2	negative
Tendon disorders			
Gudmundsen and colleagues, ^{32,34} 1987, 1989	epicondylitis lateralis, rotator cuff syndrome	15	positive
Haker and Lundeberg, ³³ 1990	lateral humeral epicondylalgia	15	negative
Lundeberg et al, ³⁸ 1987	tennis elbow	11	negative
Siebert et al, ⁴⁷ 1987	tendinopathies, elbow and others	11	negative
England et al, ²⁶ 1989	supraspinatus or bicipital tendinitis	8	positive
Meier and Kerkour, ⁴⁰ 1988	patellar or Achilles tendinitis	6	@
Muscle disorders			
Ceccherelli et al, ²⁴ 1989	cervical myofascial pain	14	@
Snyder-Mackler et al, ⁴⁸ 1986	trigger points	11	positive
Flöter and Rehfisch, ^b 1988	chronic myofascial pain	10	positive
Gallachi and colleagues, ^{28,29} 1981	tendomyotic cervical and lumbal syndrome	9	negative
Snyder-Mackler et al, ⁴⁹ 1989	trigger point, neck or back	9	positive
Waylonis et al, ⁵⁴ 1988	chronic myofascial pain	6	negative
Soft tissue disorders			
Gobelet et al, ³¹ 1986	rheumatic complaints	4	@
Falkenbach et al, ²⁷ 1987	rheumatic complaints	2	negative
Seichert et al, ⁴⁶ 1987	rheumatic complaints	2	@
Skin disorders			
Crous and Malherbe, ²⁵ 1988	chronic ulcers	8	@
Bihari and Mester, ²² 1989	crural ulcers	6	@
Santojanni et al, ⁴⁵ 1984	crural ulcers	3	negative
Other diagnosis			
Walker et al, ⁵³ 1987	trigeminal neuralgia	13	@
Moore et al, ⁴² 1988	post-herpetic neuralgia	10	positive
Walker, ⁵¹ 1985	clonus	7	positive
Ysla and McAuley, ⁵⁵ 1985	carpal tunnel syndrome	1	negative

^aOverall conclusion of the author(s): positive=statistically significant difference in the main outcome(s) between the contrasted groups, negative=no important difference in the main outcome(s) between the contrasted groups, @=pretest-posttest comparison in the experimental group without taking into account the results of the control group.

^bTH Flöter, HP Rehfisch; unpublished report.

Figure. Relationship between methodological score and conclusion (positive or negative) of the authors of the studies.

cating for each study the scores for the methodological characteristics.

The best study obtained 72% of the maximum score of 25 points. Only 7 of the 36 RCTs had 50% or more of the maximum score.^{19,21,24,32,33,52,53} This finding indicates the rather poor methodological quality of many RCTs concerning laser therapy. It should be noted, however, that for some studies only abstracts or brief reports were available.^{20,39,41,43,55} As a result of the brief and consequently incomplete description of these studies, their total scores were generally low. Therefore, in Table 1 we separately present the methodological scores of studies reported in the full-length articles and the scores of studies reported in abstracts or brief reports.

The main methodological shortcomings were lack of description of the randomization procedure, the small number of patients, no power calculation, lack of description of prognostic comparability of the groups, no follow-up after the treatment period,

no intention-to-treat analysis, carry-over effects, and an incorrect statistical analysis.

It is difficult to compare trials with different methodological qualities. In the lower range, the results of the studies may have been seriously biased because of several methodological shortcomings. Consequently, only the results of the seven best trials (those scoring 50% or more of the maximum score) are presented in some detail (Tab. 2).^{19,21,24,32,33,52,53} Three of these studies^{21,32,52} showed a positive result favoring laser therapy, whereas two studies^{19,24} demonstrated a negative result. In two studies,^{24,53} the statistical analysis was not correct, although the results of the study by Ceccherelli et al²⁴ seem to be in favor of laser therapy.

Table 3 presents the outcomes of all trials stratified by diagnosis. The overall results reflect the opinions of the authors as stated in their abstract, discussion, or conclusions. A trial was scored "positive" only if laser therapy

produced better results than did the control treatment(s). Generally, this positive score means that the differences were statistically or clinically significant. A trial was considered "negative" when the author(s) reported no differences between the study treatments or showed even better results for the control treatment(s). In nine studies, however, the authors restricted themselves to a pretest-posttest comparison in the experimental group without taking into account the results of the control group. This approach ignores the fact that the study was an RCT and probably means that no differences were found between laser therapy and the control treatment.

The Figure plots the relation between the methodological quality and the study outcomes. Included are 13 positive studies and 14 negative studies. With a methodological score of 13 points considered the cut-off point, the graph shows that 35% of the positive studies scored 13 points or more, whereas 19% of the negative studies had a score of 13 points or more. Furthermore, this figure shows that the studies with a positive outcome are, in general, of a better quality than the studies with a negative outcome.

We also investigated the relationship between the laser dosage (measured as the energy density, given in joules per square centimeter at the level of the target tissue) and the outcome of the trials, as well as the relationship between the dosage and the methodological score.⁵⁶ The laser dosage at the level of the target tissue depends on the distance between the skin and the laser apparatus, the optical system of the laser apparatus (mirrors or lens systems), the type of laser sources, the divergence of the laser beam, reflection, transmission, scattering, absorption, the depth of the treated tissue, and possibly some other factors as well. We tried to estimate the applied dosage at the level of the treated tissue for each study, using the information available supplemented by reasonable assumptions. A full description of the assessment of the applied dosage is available from the au-

Table 4. Relationship Between Laser Dosage, Methodological Score, and Result for Each Type of Laser Therapy

Reference	Dosage (J/cm ²)	Methodological Score	Result ^a
He-Ne ^b laser			
Santoianini et al, ⁴⁵ 1984	4 and 1	3	negative
Bihari and Mester, ²² 1989	3	6	@
Bliddal et al, ²³ 1987	0.608	11	negative
Tsurko et al, ⁵⁰ 1983	0.243–0.365	4	@
Meier and Kerkour, ⁴⁰ 1988	0.173	6	negative ^c
Walker et al, ⁵² 1987	0.049	15	positive
Basford et al, ¹⁹ 1987	0.043	18	negative
Walker et al, ⁵³ 1987	0.0095–0.0428	13	@
Gudmundsen and colleagues, ^{32,34} 1987, 1989	0.02	15	negative ^c
Walker, ⁵¹ 1985	0.019	7	positive
Gallachi and colleagues, ^{28,29} 1981	0.017	9	negative
Seichert et al, ⁴⁶ 1987	0.007	2	@
Lundeberg et al, ³⁸ 1987	0.005	11	negative
Kreczi and Klingler, ³⁷ 1986	0.003	11	positive
Flöter and Rehfish, ^d 1988	0.0006	10	negative ^c
Snyder-Mackler et al, ⁴⁸ 1986	0.00015	11	positive
Snyder-Mackler et al, ⁴⁹ 1989	0.00015	9	positive
Waylonis et al, ⁵⁴ 1988	...	6	negative
Gobelet et al, ³¹ 1986	...	4	negative ^c
Infrared laser or combination laser			
Ceccherelli et al, ²⁴ 1989	3.97–0.40	14	@
Bihari and Mester, ²² 1989	3	6	@
Siebert et al, ⁴⁷ 1987	2.603	11	negative
Haker and Lundeberg, ³³ 1990	0.85	15	negative
Meier and Kerkour, ⁴⁰ 1988	0.633	6	positive
England et al, ²⁶ 1989	0.498	8	positive
Beard et al, ²⁰ 1990	0.425	2	negative
de Bie et al, ²¹ 1989	0.351	15	positive
Gudmundsen and colleagues, ^{32,34} 1987, 1989	0.22	15	positive
Jensen et al, ³⁵ 1987	0.170	10	negative
Klein and Eek, ³⁶ 1990	0.162	12	negative
Palmgren et al, ⁴⁴ 1989	0.135	11	positive
Seichert et al, ⁴⁶ 1987	0.066	2	@
Flöter and Rehfish, ^d 1988	0.0216	10	positive
Crous and Malherbe, ²⁵ 1988	0.0126	8	@
Lundeberg et al, ³⁸ 1987	0.009	11	negative
Gärtner et al, ³⁰ 1989	0.0005	10	@
Falkenbach et al, ²⁷ 1987	...	2	negative
Gobelet et al, ³¹ 1986	...	4	@
Moore et al, ⁴² 1988	...	10	positive
Ysla and McAuley, ⁵⁵ 1985	...	1	negative
McAuley and Ysla, ³⁹ 1985	...	3	negative
Miyagi, ⁴¹ 1989	...	5	positive
Nivbrant and Friberg, ⁴³ 1989	...	3	positive

^aOverall conclusion of the author(s): positive=statistically significant difference in the main outcome(s) between the contrasted groups favoring laser therapy, negative=no important difference in the main outcome(s) between the contrasted groups or even better results for the control treatment, @=pretest-posttest comparison in the experimental group without taking into account the results of the control group.

^bHe-Ne=helium neon.

^cStatistically significant difference to the detriment of He-Ne laser therapy in contrast with infrared laser therapy.

^dTH Flöter, HP Rehfish; unpublished report.

thors on request. As mentioned earlier, the magnitude of the effect seems to depend on the wavelength,⁴ so the results are presented separately for He-Ne lasers and infrared or combination lasers (Tab. 4).

Optimal dosimetry for laser therapy is not yet known. Nevertheless, in many studies the laser dosage seems to be very low. Neither for the He-Ne laser nor for the infrared or combination laser could a relationship be demonstrated between the laser dosage and the result of the study. There also appeared to be no clear relationship between the dosage and the methodological score. Therefore, no conclusions can be drawn concerning the minimal effective dosage and the optimal effective dosage of laser therapy.

Discussion

The assessment of the methodological quality of the trials was based on the information provided in the publications. To assess the methodological quality of the trials described in the abstracts and brief reports, we asked the authors for more information about their study. It is possible that the trials were of a better quality than suggested by the publications. In interpreting the results, however, the reader has only the published material on which to rely. By using all available RCTs dealing with the efficacy of laser therapy for musculoskeletal disorders and skin disorders and by formulating explicit inclusion criteria, we tried to avoid selection bias in this meta-analysis.^{57,58}

Although there is certainly consensus about the criteria for an internally valid RCT, the weights that should be given to these criteria remain arbitrary to some extent. Table 1, however, allows the reader to recalculate the scores using a different set of weights. By using these criteria, we believed we were able to distinguish good studies from bad studies.

The large variety in methodological quality is one of the reasons we chose not to pool the outcomes of the available RCTs. Pooling the results is further complicated by the heterogeneity of diagnoses, the great variety in treatment characteristics, and the differences in outcome measurements. By pooling the results, the conclusion may be difficult to interpret clinically.

To identify patients who are susceptible to laser therapy, more adequate diagnostic procedures are necessary. Currently, diagnostic procedures contribute only in a rather global sense to the choice of physical therapy intervention.⁵⁹ In order to be able to define homogeneous groups of patients, much more knowledge is needed about prognostically relevant factors.

Not only is the efficacy of a new therapy relevant, but one should also be aware of adverse effects. Information from the 36 RCTs revealed that only a few researchers have investigated the adverse effects of laser therapy (TH Flöter, HP Rehfish; unpublished report; 1988).^{*} Most of these researchers observed no side effects. The others reported the following adverse effects: transient tingling^{19,54}; mild erythema¹⁹; a burning sensation²³; and increased pain, numbness, and skin rash.⁵⁴ Walker, in an earlier study,⁶⁰ also observed increased pain and changed from a continuous to a pulsating mode of laser therapy. In the studies of Basford et al¹⁹ and Bliddal et al,²³ the adverse effects involved both treated and untreated (placebo laser) patients.

Conclusions and Recommendations

Our methodological review clearly indicates that the majority of the studies investigating the efficacy of laser therapy showed major flaws in design. Nevertheless, some of the better trials^{21,24,32,52} suggest that laser therapy is effective. Laser therapy appears to

have a specific therapeutic effect especially for posttraumatic joint disorders,²¹ myofascial pain,²⁴ and rheumatoid arthritis,⁵² although up to now the degree of certainty about the efficacy of laser therapy has been rather weak.

There is a need for further well-designed RCTs to determine the efficacy of laser therapy. Based on the results of our analysis, we can make the following recommendations for future studies. More attention should be paid to factors such as the description of the randomization procedure, the power of the study associated with the sample size, and the prognostic comparability of the groups. The statistical analysis should be carried out according to the intention-to-treat method. Furthermore, a full description of the dosimetry parameters is necessary.

In the evaluation of a new therapy, it is often difficult to determine the optimal dosage and treatment schedule. Even the minimal effective dosage is in most cases unknown. For laser therapy, an additional question is which wavelength will be optimal. In this respect, further studies are also needed to investigate the aspects of dosimetry of laser therapy. The fact that the better studies, particularly, showed a beneficial effect of laser therapy seems to justify the expectation that future well-designed studies will lend support to the efficacy of laser therapy for at least some indications.

References

- 1 Baxter GD, Bell AJ, Allen JM, Ravey J. Low-level laser therapy: current clinical practice in Northern Ireland. *Physiotherapy*. 1991;77: 171-178.
- 2 Schut HA, Teirlinck CJPM. Low-power laser: an investigation of the Dutch market. *Journal of Rehabilitation Sciences*. 1989;2(4):121-123.
- 3 King PR. Low-level laser therapy: a review. *Lasers in Medical Science*. 1989;4:141-150.
- 4 Basford JR. Low-energy laser therapy: controversies and new research findings. *Lasers Surg Med*. 1989;9:1-5.
- 5 Kitchen SS, Partridge CJ. A review of low-level laser therapy. *Physiotherapy*. 1991;77: 161-168.

*References 19, 23, 30, 33, 36, 37, 41, 48, 51, 54.

- 6 Belkin M, Schwartz M. New biological phenomena associated with laser radiation. *Health Phys.* 1989;56:687-690.
- 7 Karu T. Photobiology of low-power laser effects. *Health Phys.* 1989;56:691-704.
- 8 Spector WS. *Handbook of Biological Data*. Philadelphia, Pa: WB Saunders Co; 1956.
- 9 Bouter LM, ter Riet G, Koes BW, et al. Meta-analysis for physiotherapists. In: *Proceedings of the Third International Physiotherapy Congress—Hong Kong, 1990*. Sydney, Australia: Link Printing Pty Ltd; 1990.
- 10 Chalmers TC, Smith H, Blackburn B, et al. A method for assessing the quality of a randomized control trial. *Controlled Clin Trials.* 1981;2:31-49.
- 11 Pocock SJ. *Clinical Trials: A Practical Approach*. Chichester, England: John Wiley and Sons Ltd; 1989.
- 12 Meinert CL. *Clinical Trials*. New York, NY: Oxford University Press Inc; 1986: vol 8.
- 13 Fowkes FGR, Fulton PM. Critical appraisal of published research: introductory guidelines. *Br Med J [Clin Res]*. 1991;302:1136-1140.
- 14 Streiner DL, Norman GR, Munroe Blum H. *PDQ Epidemiology*. Toronto, Ontario, Canada: BC Decker Inc; 1989.
- 15 ter Riet G, Kleijnen J, Knipschild P. Acupuncture and chronic pain: a criteria-based meta-analysis. *J Clin Epidemiol.* 1990;43:1191-1199.
- 16 Koes BW, Bouter LM, Beckerman H, et al. Physiotherapy exercises and back pain: a blinded review. *Br Med J [Clin Res]*. 1991;302:1572-1576.
- 17 Koes BW, Assendelft WJJ, van der Heijden GJMG, et al. Spinal manipulation and mobilization for back and neck pain: a blinded review. *Br Med J [Clin Res]*. 1991;303:1298-1303.
- 18 Kleijnen J, Knipschild P, ter Riet G. Clinical trials of homeopathy. *Br Med J [Clin Res]*. 1991;302:316-323.
- 19 Basford JR, Sheffield CG, Mair SD, et al. Low-energy helium neon laser treatment of thumb osteoarthritis. *Arch Phys Med Rehabil.* 1987;68:794-797.
- 20 Beard M, Hansel N, Furniss A. The treatment of rheumatoid arthritis with low-power laser. In: *Proceedings of the Third International Physiotherapy Congress—Hong Kong, 1990*. Sydney, Australia: Link Printing Pty Ltd; 1990. Abstract.
- 21 de Bie RA, Steenbruggen RA, Bouter LM. Effect of laser therapy on ankle sprains. *Nederlands Tijdschrift voor Fysiotherapie.* 1989;99(special edition):4-7.
- 22 Bihari I, Mester AR. The biostimulative effects of low-level laser therapy of long-standing crural ulcers using helium neon laser, helium neon plus infrared lasers, and noncoherent light: preliminary report of a randomized double-blind comparative study. *Laser Therapy.* 1989;1(2):75-78.
- 23 Bliddal H, Hellesen C, Ditlevsen P, et al. Soft laser therapy of rheumatoid arthritis. *Scand J Rheumatol.* 1987;16:225-228.
- 24 Ceccherelli F, Altafini L, Lo Castro G, et al. Diode laser in cervical myofascial pain: a double-blind study versus placebo. *The Clinical Journal of Pain.* 1989;5:301-304.
- 25 Crous LC, Malherbe CP. Laser and ultraviolet light irradiation in the treatment of chronic ulcers. *The South-African Journal of Physiotherapy.* 1988;44(3):73-77.
- 26 England S, Farrell AJ, Coppock JS, et al. Low-power laser therapy of shoulder tendinitis. *Scand J Rheumatol.* 1989;18:427-431.
- 27 Falkenbach A, Brech A, Bühring M. Bei Erkrankungen aus dem rheumatischen Formenkreis hat eine kombinierte Infrarot- und HeNe-Lasertherapie keinen akuten analgetischen Effekt. *Z Phys Med Baln Med Klim.* 1987;16:316-317.
- 28 Gallachi G, Muller W. Akupunktur und Laserstrahlenbehandlung beim Cervical- und Lumbalsyndrom. *Zeitschrift für Physikalische Medizin.* 1981;2(10):95-102.
- 29 Gallachi G, Muller W, Plattner GR, et al. Akupunktur- und Laserstrahlbehandlung beim Zervical- und Lumbalsyndrom. *Schweiz Med Wochenschr.* 1981;111:1360-1366.
- 30 Gärtner Ch, Becker M, Dill H, et al. Analgesy by low-power laser (lpl): a controlled double-blind study in ankylosing spondylitis (SPA). *Lasers Surg Med.* 1989;1(suppl 1):30. Abstract.
- 31 Gobelet C, Meier JL, Volken H. "Mid" ou "mythe" laser et pathologie abarticulaire. In: Simon L. *Actualité's en rééducation fonctionnelle et readaptation*. Paris, France: Masson Editeur; 1986.
- 32 Gudmundsen J, Vikne J. Laserbehandling av epicondylitis humeri og rotatorcuffsyndrom. *Nor Tidsskr Idrettsmed.* 1987;2:6-15.
- 33 Haker E, Lundeberg T. Laser treatment applied to acupuncture points in lateral humeral epicondylalgia: a double-blind study. *Pain.* 1990;43:243-247.
- 34 Hartvig P, Vikne J, Gudmundsen J. Hjelper laserbehandling mot tendinit? *Tidsskr Nor Laegeforen.* 1989;109:2184.
- 35 Jensen H, Harreby M, Kjer J. Is infrared laser effective in painful arthrosis of the knee? *Ugeskr Laeger.* 1987;149:3104-3106.
- 36 Klein RG, Eek BC. Low-energy laser treatment and exercise for chronic low back pain: double-blind controlled trial. *Arch Phys Med Rehabil.* 1990;71:34-37.
- 37 Kreczi T, Klingler D. A comparison of laser acupuncture versus placebo in radicular and pseudoradicular pain syndromes as recorded by subjective responses of patients. *Acupunct Electrother Res.* 1986;11:207-216.
- 38 Lundeberg T, Haker E, Thomas M. Effect of laser versus placebo in tennis elbow. *Scand J Rehabil Med.* 1987;19:135-138.
- 39 McAuley R, Ysla R. Soft laser: a treatment for osteoarthritis of the knee? *Arch Phys Med Rehabil.* 1985;66:553-554. Abstract.
- 40 Meier JL, Kerkour K. Traitement laser de la tendinite. *Medecine et Hygiene.* 1988;46:907-911.
- 41 Miyagi K. Double-blind comparative study on the effect of low-energy laser irradiation to rheumatoid arthritis. In: *Current Awareness of Excerpta Medica*. Amsterdam, the Netherlands: Elsevier Science Publishers BV; 1989;25:315.
- 42 Moore KC, Hira N, Kumar PS. A double-blind crossover trial of low-level laser therapy in the treatment of post herpetic neuralgia. *Laser Therapy.* 1988;pilot issue:7-9.
- 43 Nivbrant B, Friberg S. Therapeutic laser treatment in gonarthrosis. *Acta Orthop Scand.* 1989;60(suppl 231):33. Abstract.
- 44 Palmgren N, Jensen GF, Kaae K, et al. Low-power laser therapy in rheumatoid arthritis. *Lasers in Medical Science.* 1989;4:193-196.
- 45 Santoianni P, Monfrecola G, Martellota D, et al. Inadequate effect of helium-neon laser on venous leg ulcers. *Photodermatol.* 1984;1:245-249.
- 46 Seichert N, Schops P, Siebert W, et al. Wirkung einer Infrarot-Lasertherapie bei weichteilrheumatischen Beschwerden im Doppel-blindversuch. *Therapiewoche.* 1987;37:1375-1379.
- 47 Siebert W, Seichert N, Siebert B, et al. What is the efficacy of "soft" and "mid" lasers in therapy of tendinopathies? *Arch Orthop Trauma Surg.* 1987;106:358-363.
- 48 Snyder-Mackler L, Bork CE, Bourbon B, et al. Effect of helium-neon laser on musculoskeletal trigger points. *Phys Ther.* 1986;66:1087-1090.
- 49 Snyder-Mackler L, Barry AJ, Perkins AI, Soucek MD. Effects of helium-neon laser irradiation on skin resistance and pain in patients with trigger points in the neck and back. *Phys Ther.* 1989;69:336-341.
- 50 Tsurko VV, Mul'diiarov PJa, Sigidin JaA. Lazernaia terapiia revmatoidnogo artrita (klinikomorfologischeskoe issledovanie). *Ter Arkh.* 1983;55(7):97-102.
- 51 Walker JB. Temporary suppression of clonus in humans by brief photostimulation. *Brain Res.* 1985;340:109-113.
- 52 Walker JB, Akhanjee LK, Cooney MM, et al. Laser therapy for pain of rheumatoid arthritis. *The Clinical Journal of Pain.* 1987;3:54-59.
- 53 Walker JB, Akhanjee LK, Cooney MM, et al. Laser therapy for pain of trigeminal neuralgia. *The Clinical Journal of Pain.* 1987;3:183-187.
- 54 Waylonis GW, Wilke S, O'Toole DO, et al. Chronic myofascial pain: management by low-output helium-neon laser therapy. *Arch Phys Med Rehabil.* 1988;69:1017-1020.
- 55 Ysla R, McAuley R. Effects of low-power infra-red laser stimulation on carpal tunnel syndrome: a double-blind study. *Arch Phys Med Rehabil.* 1985;66:577. Abstract.
- 56 de Bie RA, Beckerman H, De Cuyper HJ, et al. Dosis en effect van lasertherapie: overzicht van de beschikbare therapeutische experimenten. *Nederlands Tijdschrift voor Fysiotherapie.* 1991;101(9):196-202.
- 57 Chalmers TC, Levin H, Sacks HS, et al. Meta-analysis of clinical trials as a scientific discipline. I: control of bias and comparison with large cooperative trials. *Stat Med.* 1987;6:315-325.
- 58 Sacks HS, Berrier J, Reitman D, et al. Meta-analyses of randomized controlled trials. *N Engl J Med.* 1987;316:450-455.
- 59 Guccione AA. Physical therapy diagnosis and the relationship between impairments and function. *Phys Ther.* 1991;71:499-504.
- 60 Walker J. Relief from chronic pain by low-power laser irradiation. *Neurosci Lett.* 1983;43:339-344.