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SYSTEMATIC REVIEW

Effect of low-level laser therapy on pain and function of patients with shoulder tendinopathy: A systematic review

Efeito do laser de baixa intensidade na dor e na funcionalidade de pacientes com tendinopatia de ombro: uma revisão sistemática

Efecto del láser de baja intensidad sobre el dolor y la funcionalidad de pacientes con tendinopatía del hombro: una revisión sistemática

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ABSTRACT | Among the various existing physiotherapeutic interventions, low-level laser therapy (LLLT) is broadly used for treating musculoskeletal disorders. Evidence suggests that LLLT is effective in modulating inflammatory mediators, contributing to tissue repair and thus being indicated for the treatment of inflammatory conditions in general. However, heterogeneous results have been reported regarding its efficacy for shoulder tendinopathies. Thus, the aim of this study was to systematically review randomized controlled trials on the effects of LLLT on pain and function outcomes of patients with shoulder tendinopathy. Two reviewers independently searched the PubMed, SciELO, Cochrane, and PEDro databases. We included randomized controlled trials of humans diagnosed with shoulder tendinopathy and treated with LLLT, with outcome measures of pain and/or function. The risk of bias of each study was assessed using the PEDro scale. Eight studies (73%) were considered as having low risk of bias and three (27%) were considered as having high risk. Eleven studies, involving 486 participants, were included in this review. LLLT showed statistically significant pain reduction in 45% of the studies, and only one study demonstrated a statistically significant increase in function. Further systematic reviews are still needed for assessing the additive effect of LLLT with exercise, as well as the effect of LLLT using recommended dosages in the treatment of shoulder tendinopathy.

Keywords | Tendinopathy; Shoulder; Laser Therapy; Pain; Function.

RESUMO | Dentre as diferentes intervenções fisioterapêuticas existentes, a terapia com laser de baixa intensidade (LBI) é altamente utilizada em distúrbios musculoesqueléticos. Evidências sugerem que o LBI é eficaz na modulação de mediadores inflamatórios, contribuindo para o reparo tecidual e sendo, portanto, indicado para o tratamento de condições inflamatórias em geral. Contudo, resultados heterogêneos foram relatados sobre sua eficácia em tendinopatias de ombro. Assim, o objetivo deste estudo foi revisar sistematicamente ensaios clínicos randomizados sobre os efeitos do LBI na dor e na funcionalidade de pacientes com tendinopatia de ombro. Dois revisores realizaram independentemente buscas nas bases de dados PubMed, SciELO, Cochrane e PEDro. Foram incluídos ensaios clínicos randomizados, com seres humanos diagnosticados com tendinopatia de ombro e submetidos ao LBI, com desfechos de dor e/ou funcionalidade. A avaliação do risco de viés de cada estudo foi realizada por meio da escala PEDro. Oito estudos (73%) foram considerados com menor risco de viés, e três (27%) foram considerados com alto risco de viés. Onze estudos, totalizando 486 participantes, foram incluídos nesta revisão. O LBI reduz de forma estatisticamente significativa a dor em 45% dos estudos, e apenas um estudo apresentou

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aumento estatisticamente significativo na funcionalidade. Futuras revisões sistemáticas sobre o efeito combinado de LBI e exercícios, assim como sobre o efeito da terapia de LBI com dosagens recomendadas no tratamento de tendinopatias de ombro, são ainda necessárias.
Descritores | Tendinopatia; Ombro; Terapia a laser; Dor; Funcionalidade.

RESUMEN | Entre las diferentes intervenciones fisioterapéuticas existentes, la terapia con láser de baja intensidad (LBI) es muy utilizada en el tratamiento de los trastornos musculoesqueléticos. Las evidencias apuntan que la LBI es eficaz en la modulación de mediadores inflamatorios, contribuyendo a la reparación de tejidos, y está indicada para el tratamiento de afecciones inflamatorias en general. Sin embargo, se han informado resultados heterogéneos sobre su eficacia en las tendinopatías del hombro. Este trabajo tuvo como objetivo revisar sistemáticamente ensayos clínicos aleatorios sobre los efectos de la LBI acerca del dolor y la funcionalidad de pacientes con tendinopatía del hombro. Dos revisores realizaron de forma independiente búsquedas en las bases de datos PubMed, SciELO, Cochrane y PEDro. Se incluyeron los ensayos clínicos aleatorios de humanos diagnosticados con tendinopatía del hombro sometidos a terapia con láser como tratamiento, con medidas de dolor y/o resultados funcionales. La evaluación del riesgo de sesgo de cada estudio se realizó mediante la escala PEDro. Ocho estudios (73%) se consideraron de menor riesgo de sesgo, y tres (27%) se consideraron de alto riesgo de sesgo. Once estudios, con un total de 486 participantes, se incluyeron en esta revisión. La LBI redujo de manera significativa el dolor estadísticamente en el 45% de los estudios y solo uno mostró un aumento estadísticamente significativo en la funcionalidad. Todavía se necesitan revisiones sistemáticas adicionales del efecto combinado de la LBI con ejercicios, así como el efecto de la LBI con las dosis recomendadas en el tratamiento de la tendinopatía del hombro.
Palabras clave | Tendinopatía; Hombro; Terapia por Láser; Dolor; Funcionalidad.

INTRODUCTION

Shoulder complex disorders are among the most common causes of musculoskeletal dysfunctions[1,2]. The incidence of shoulder pain is second only to low back pain, affecting between 16% and 21% of the population[3,4] and represents 7 to 25 per thousand general practice consultations per year[5].

The causes for shoulder complex disorders are varied, most of which are related to diseases in joints or adjacent regions, such as subacromial impingement syndrome (SIS), which includes biceps tendinitis and rotator cuff tendinitis, in addition to calcific tendinitis, subacromial bursitis and rotator cuff tear[6,7]. The main signs and symptoms are pain, limitation of motion and strength, and loss of shoulder function[4]. Tendinitis is a type of tendinopathy[8], a non-fibrous lesion that can occur in any joint due to overuse or repetitive use of the tendon. The most prevalent shoulder complex tendinopathy is that of the supraspinatus tendon[5].

Treatment for shoulder tendinopathies includes both pharmacological interventions, such as nonsteroidal anti-inflammatory drugs and corticosteroid injections, and non-pharmacological interventions, such as physiotherapy, which uses electrothermal and kinesiological therapy for reducing pain and improving range of motion[2]. Among the various suggested physiotherapeutic interventions, low-level laser therapy (LLLT) is broadly used in rheumatological and musculoskeletal disorders, having shown analgesic, anti-inflammatory and biostimulating effects[9]. Evidence suggests that LLLT is effective in modulating inflammatory mediators, such as TNF-α, IL-1β, IL-6, IL-10 and prostaglandin E_2, both in experimental and clinical studies, reducing pain and contributing to tissue repair[10,11]. In addition, LLLT induces cell proliferation, collagen and protein synthesis, as well as wound healing through direct irradiation without thermal response[3,9], and is therefore indicated for treating inflammatory conditions in general, such as tendinopathies.

However, controversial results have been reported after the use of LLLT therapy in the treatment of shoulder tendinopathies[4,12]. In addition, a systematic review of LLLT use in tendinopathies in general, which also examined pain-related and functional outcomes, reported conflicting evidence about the effectiveness of LLLT in the treatment of tendinopathy[13]. Of the 25 studies included in this systematic review, 12 reported positive effects of LLLT and 13 were inconclusive or showed no effect[13]. The specific effect of LLLT on shoulder tendinopathies, however, has not yet been systematically reviewed. Therefore, this study aimed to systematically review randomized clinical trials on the effects of LLLT on pain and function in patients with shoulder tendinopathy.

METHODOLOGY

This systematic review was carried out in accordance with the recommendations of the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes[14] (PRISMA), previously registered with the International Prospective Register of Systematic Reviews (PROSPERO) (registration: CDR42019135198).

The search was carried out in the PubMed, SciELO, Cochrane and PEDro databases, for studies published up to April 2019, using the following combinations of descriptors: (1) *tendonitis* OR *tendinitis* OR *tendinopathy* OR *subacromial impingement* OR *impingement syndrome* OR *shoulder tendonitis* OR *shoulder tendinitis* OR *rotator cuff tendonitis* OR *rotator cuff tendinitis* OR *supraspinatus tendonitis* OR *supraspinatus tendinitis*; and (2) *low-level laser therapy* OR *low-intensity laser therapy* OR *low energy laser therapy* OR *phototherapy* OR *HeNe laser* OR *IR laser* OR *GaAlAs* OR *GaAs*; and (3) *randomized clinical trial* and corresponding Boolean terms.

The studies reviewed were selected independently by two authors of this study based on the following inclusion criteria: (1) randomized clinical trials; (2) conducted with humans diagnosed with shoulder tendinopathy; (3) who were receiving laser therapy treatment, in combination or not with other therapies; and (4) with outcomes of pain and/or functional loss. In case of disagreement over study selection, a third reviewer was consulted. Studies evaluating the effect of laser therapy in the treatment of tendinopathies of joint complexes other than the shoulder complex or that used high power laser therapy instead of low power, or even used laser therapy in acupuncture points or in subjects without shoulder tendinopathy, were excluded.

The following data were extracted from the selected studies by two independent reviewers: author and year of publication; sample characteristics; diagnosis (according to the study itself); laser parameters; comparative intervention; outcomes; main results and PEDro score.

Potential bias in each study was assessed using the PEDro scale, in order to ensure reliability and validity[15-17]. PEDro scores range from 1 to 10. Clinical trials with a score greater than 6 were considered to have a lower risk of bias, and studies with a score less than or equal to 6 were considered to have a high bias risk[18].

Data analysis was performed descriptively. First, a general comparison was performed to assess the effects of laser treatment for shoulder tendinopathies on pain and functional outcomes. Next, a subgroup analysis was carried out to examine the effect of laser treatment in relation to specific diagnoses and to the types of laser used.

RESULTS

Figure 1 presents the complete research flowchart. The characteristics of the included articles are shown in Table 1. While six studies did not report significant effects after treatment with LLLT[9,12,19-21], five studies[4,5,17,20,21] reported some positive effects of LLLT.

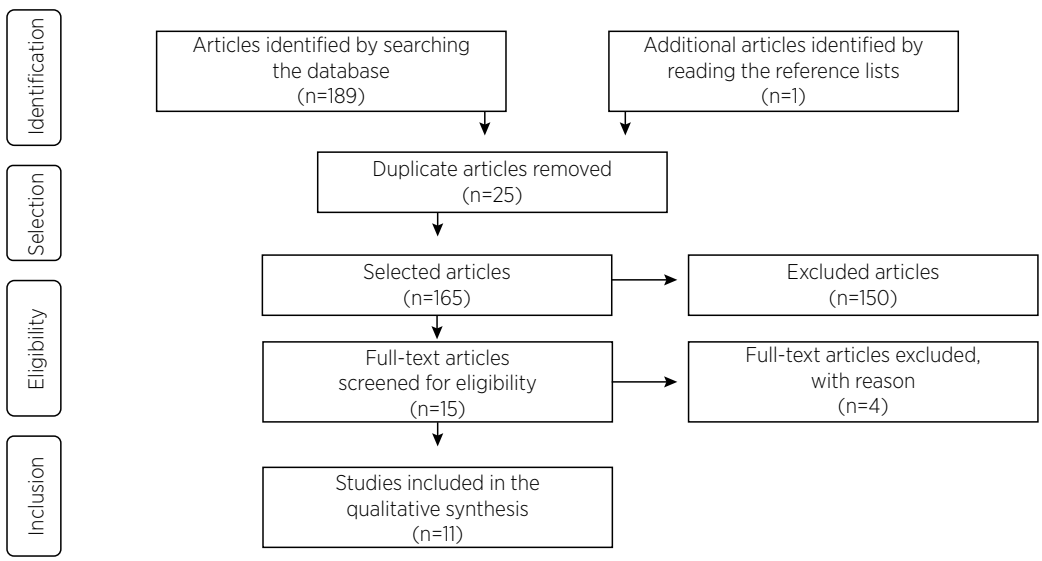

Figure 1. Search strategy flowchart.

Source: The authors.

Table 1. Characteristics of the included articles

Author and year	Sample (N; NFem; mean age)	Diagnosis	Laser parameters	Design (intervention group vs comparison group)	Outcomes	Main results	Score of PEDro
Abrisham et al. (2011)[4]	80; 50; 51.7 years	Subacromial impingement syndrome	IR Laser, λ: 890nm, mode: pulsating, ΔE:2 to 4J/cm², P:7 to 10W, F:80 to 1500Hz	Laser therapy + exercise vs Placebo laser therapy + exercise	VAS + ROM	VAS: G1 > G2; ROM: G1 > G2.	9
Bal et al. (2009)[19]	44; 28; 52.4 years	Subacromial impingement syndrome	Laser GaAs, λ: 904nm, mode: pulsating, ΔE:1.6J/cm², F:5500Hz, P average:13.2mW	Laser therapy + exercise at home vs Exercise at home	VAS + SPADI + UCLA	SPADI: G1 = G2; VAS: G1 = G2; UCLA: G1 = G2.	7
Dogan et al. (2010)[9]	52; 33; 53.5 years	Subacromial impingement syndrome	IR Laser, GaAlAs, λ:850nm, mode: continuous, ΔE:3J/cm², P:10mV	Cold compress + laser therapy + exercise vs Cold compress + placebo laser therapy + exercise	VAS + SPADI + ROM	VAS: G1 = G2; SPADI: G1 = G2; ROM: G1 = G2.	9
England et al. (1989)[23]	30; 15; 48 years	Supraspinatus tendinitis and bicipital tendinitis	IR Laser, GaAs, λ:904nm, F:4.000Hz. P:10W. ΔE:3J/cm²	Active laser therapy vs G2a: placebo laser therapy . G2b: drug therapy	VAS + ROM	VAS: G1 > G2a e G1 > G2b; ROM: G1> G2a e G1 > G2b.	6
Eslamian et al. (2011)[22]	50; 26; 50.1 years	Rotator cuff tendinitis	Diode laser IV, GaAlAs, λ:830nm, P average:100mW, ΔE:4J/cm²	Laser therapy + superficial heat + ultrasound + TENS + exercises vs Placebo laser therapy + superficial heat + ultrasound + TENS + exercises	VAS + ROM + DASH	VAS: G1 > G2; ROM: G1 = G2; DASH: G1 > G2;	7
Otadi et al. (2012)[5]	44; 44; 48.7 years	Shoulder tendinitis	IR Laser GaAlAs, λ:830nm, P:30mW, ΔE:1J/cm²	Laser therapy + ultrasound + exercises vs Ultrasound + exercises	VAS + Sensibility + CMS + MS	VAS: G1 = G2; Sensibility:G1 = G2; CMS: G1 = G2; FM: G1 > G2;	6
Saunders (1995)[24]	24; 12; 50.2 years	Supraspinatus tendinitis	IR Laser, λ:820nm, P:40mW, ΔE:30J/cm², F:5000Hz	Laser therapy + treatment course + educational material vs Placebo laser therapy + treatment course + educational material	VAS + MS + Sensibility	VAS: G1 > G2; FM: G1 > G2. Sensibility: G1 > G2.	9
Saunders (2003)[25]	36; 17; 56.5 years	Supraspinatus tendinosis	IR Laser, λ:820nm, P:50mW, ΔE:30J/cm², F:5000Hz	Laser therapy + counseling vs G2a: ultrasound + counseling; G2b: counseling	MS + VAS + Pain Diary + Sensibility	FM: G1 > G2a e G2b; VAS: G1 > G2a e G2b; Pain Diary: G1 e G2a > G2b;Sensibility: G1 > G2b e G1 = G2a;	2
Vecchio et al. (1993)[21]	35; 25; 54.4 years	Rotator cuff tendinitis	Diode laser GaAlAs, λ:830nm, ΔE:1J/cm², P:30mW	Laser therapy + exercise vs Placebo laser therapy + exercise	ROM + VAS	ROM: G1 = G2; VAS: G1 = G2.	8
Yavuz et al. (2014)[20]	31; 14; 44.4 years	Subacromial impingement syndrome	Diode laser IV, GaAlAs, λ:850nm, P:100mV, continuous mode, ΔE:3J/cm²	Laser therapy + exercise + heat vs Ultrasound + exercise + heat	SPADI + VAS	SPADI: G1 = G2; VAS: G1 = G2.	7
Yeldan et al. (2009)[12]	60; 47; 55.1 years	Subacromial impingement syndrome	Diode laser GaAs, λ:904mn, F:5 to 7000Hz, P:27 or 50W, ΔE:3J/cm²	Laser therapy + exercise + cryotherapy vs Placebo laser therapy + exercise+ cryotherapy	MS + ROM + VAS + DASH + CMS + SDQ	FM: G1 = G2; ROM: G1 = G2; VAS: G1 = G2; DASH: G1 = G2; CMS: G1 = G2; SDQ: G1 = G2.	7

IR: infrared; λ: wavelength; P: power; F: frequency; ΔE: energy density; VAS: visual analog scale; ROM: range of motion; SPADI: shoulder pain and disability index; MS: muscle strength; CMS: Constant-Murley score; UCLA: University of California-Los Angeles end-result score; DASH: disabilities of the arm, shoulder and hand; SDQ: shoulder disability questionnaire; >: there was a significant difference; =: there was no significant difference; G1: intervention group; G2: comparison group; G2a: comparison group 1; G2b: comparison group 2.

Five studies[4,22,23-25] (45%) showed a statistically significant decrease in pain as measured using the visual analog scale (VAS) after the use of LLLT in comparison with placebo or other therapeutic interventions. The other six studies (55%), which did not find any significant result in terms of VAS scores[5,9,12,19-21], were compared with exercise therapy, combined or not with placebo laser therapy and other therapeutic interventions.

Five studies did not measure shoulder function[4,21,23-25]. Among the six studies that did, a statistically significant improvement in function was observed in only one of them[22], in which laser therapy was combined with other interventions, such as exercise, ultrasound, TENS and surface heat, using the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire for evaluation. The results of LLLT therapy in terms of pain and functional outcomes are shown in Table 2.

Table 2. Pain and functional outcomes

1st author, year	Pain outcome (VAS)	Functional outcome
Abrisham, 2011[4]	P	NA
Bal, 2009[19]	ND	ND (SPADI, UCLA)
Dogan, 2010[9]	ND	ND (SPADI)
England, 1989[23]	P	NA
Eslamian, 2011[22]	P	P (DASH)
Otadi, 2012[5]	ND	ND (CMS)
Saunders, 1995[24]	P	NA
Saunders, 2003[25]	P	NA
Vecchio, 1993[21]	ND	NA
Yavuz, 2014[20]	ND	ND (SPADI)
Yeldan, 2009[12]	ND	ND (DASH, CMS, SDQ)

P: statistically significant in favor of laser; NA: not assessed; ND: no statistically significant difference between groups; VAS: visual analog scale; SPADI: shoulder pain and disability index; UCLA: University of California-Los Angeles end-result score; DASH: disabilities of the arm, shoulder and hand; CMS: Constant-Murley score; SDQ: shoulder disability questionnaire.

Subacromial impingement syndrome was the most prevalent diagnosis among the studies included in this review. Regarding the effects of laser therapy for this clinical condition, among the five studies addressing the subacromial impingement syndrome, only one showed significant results[4], with improved VAS scores in patients who underwent laser therapy and an exercise program, compared to the group treated with placebo and an exercise program. Table 3 shows the results of LLLT on pain and functional outcomes in relation to tendinopathy diagnoses.

Table 3. Pain and functional outcomes grouped by medical diagnosis

Diagnosis	No. of studies/ 1st author /year	No. of results for pain	No. of results for function
Subacromial impingement syndrome	5 studies: Abrisham, 2011[4] Bal, 2009[19] Dogan, 2010[9] Yavuz, 2014[20] Yeldan, 2009[12]	(P=1, ND=4); P ND ND ND ND	(NA=5); NA NA NA NA NA
Rotator cuff tendinitis	2 studies: Eslamian, 2011[22] Vecchio, 1993[21]	(P=1, ND=1); P ND	(P=1, NA=1); P NA
Supraspinatus tendinitis	1 study: Saunders, 1995[24]	(P=1); P	(NA=1); NA
Supraspinatus tendinosis	1 study: Saunders, 2003[25]	(P=1); P	(NA=1); NA
Shoulder tendinitis	1 study: Otadi, 2012[5]	(ND=1); ND	(ND=1); ND
Supraspinatus tendinitis and bicipital tendinitis	1 study: England, 1989[23]	(P=1); P	(NA=1); NA

P: statistically significant in favor of laser; ND: no statistically significant difference between groups; NA: not assessed.

Table 4. Pain and functional outcomes grouped by type of laser

Type of laser	No. of studies/ 1st author /year	No. of results for pain	No. of results for function
890nm – 904nm	4 studies: Abrisham, 2011[4] Bal, 2009[19] England, 1989[23] Yeldan, 2009[12]	(P=2, ND=2); P ND P ND	(NA=2, ND=2); NA ND NA ND
820nm – 850nm	7 studies: Dogan, 2010[9] Eslamian, 2011[22] Otadi, 2012[5] Saunders, 1995[24] Saunders, 2003[25] Vecchio, 1993[21] Yavuz, 2014[20]	(P=3, ND=4); ND P ND P P ND ND	(P=1, NA=3, ND=3); ND P ND NA NA NA ND

P: statistically significant in favor of laser; ND: no statistically significant difference between groups; NA: not assessed.

Regarding the type of laser used in the studies, with the laser's wavelength varying from 820nm to 850nm (AsGaAl) and from 890nm to 904nm (AsGa), two[4,23] of the four studies (50%) that examined AsGa laser use showed a statistically significant decrease in pain; and three[22,24,25] of the seven studies (43%) that addressed AsGaAl laser use found a statistically significant decrease in VAS score for pain, one of which[22] showing a statistically significant improvement in DASH-measured function. Table 4 presents the outcomes for pain and functional outcomes in relation to the type of laser used.

DISCUSSION

This was the first systematic review of the effects of LLLT on pain and functional outcomes in patients with shoulder tendinopathy. Previous reviews have assessed the effects of LLLT therapy on different tendinopathies, or have included studies that addressed the use of both low and high power laser therapy[26]. This review was conducted in accordance with PRISMA[14] recommendations, ensuring consistency and uniformity in systematic review reporting. In addition, we registered this review prospectively with PROSPERO. We found that 5 of the 11 studies included showed a significant improvement in pain with the use of LLLT for shoulder tendinopathies; and that only 1 of the 6 studies that assessed shoulder function showed functional improvements.

Among the studies included in this review, only 54% assessed the effect of LLLT on functional outcomes of patients with shoulder tendinopathy; and only one reported a statistically significant improvement in function. In a systematic review of laser therapy for previous shoulder tendinopathies, Haslerud et al.[26] showed that LLLT is a safe and effective option for pain treatment in patients with shoulder tendinopathy[26]. However, unlike our review, this assessment included studies addressing the use of high-power laser therapy and that did not only examine tendinopathies, but also trigger points and laser therapy to stimulate acupuncture points, increasing the number of included studies, and thus the affected population, preventing a direct comparison with our findings.

In a systematic review of nondrug and nonsurgical treatments for shoulder conditions, Hawk et al.[27] reinforced that kinesiotherapy combined with LLLT resulted in improvements in shoulder pain and function[27], corroborating the findings of Hasterud et al.[26], who affirm that adding LLLT to an exercise-based therapy program can accelerate the improvement of physical function, because when inflammation is controlled and tendon repair is stimulated, the final result is pain reduction and faster recovery[26]. Our findings are in line with previous results, since most studies showing pain reduction – in addition to the sole study showing significant results for shoulder function improvement – addressed LLLT in combination with other types of physical therapy interventions[4,22-25].

This review's heterogeneity of results can be due to the different diagnosed pathologies and the different parameters of laser therapy used in the selected studies. According to Lopes-Martins et al.[28], there are two important factors explaining the studies' failure to find positive effects: coverage of the affected population and incorrect dosage[28]. The efficacy of laser therapy in tissues depends on some conditions, such as wavelength, power, frequency, the amount of energy applied, the type of tissue and its absorption capacity[29]. For shoulder tendinopathies, the recommendations of the World Association for Photobiomodulation Therapy (WALT) vary according to the wavelength and the type of laser used. For the GaAs laser, with a wavelength of 904nm, the recommendation are doses ranging from 2 to 4 Joules in 2 to 3 points per $1cm^2$. As for the GaAIAs laser, with a wavelength ranging from 780nm to 860nm, doses of 4 to 8 Joules in 1 to 3 points per $1cm^2$ are recommended. Although these dosage guidelines for the treatment of joint disorders and tendinopathies have existed since 2005[29], we still have observed a considerable variability in the parameters used in the studies reviewed here. It thus appears that there are still doubts about the appropriate dosage and wavelength – doubts that should be clarified with further research on the subject[29].

The findings of this systematic review indicate that LLLT for shoulder tendinopathies should be used with caution to relieve pain and improve function, since the findings of the included studies proved to be controversial. LLLT also seems to have a role as a complementary therapy, in combination with a comprehensive exercise program, because adding LLLT to conservative interventions has resulted in improved outcomes[22].

This systematic review has some limitations. Only studies published in English were included; three studies[5,23,25] presented a high risk of bias, in addition to heterogeneity of methods, diagnosed pathologies, types of laser and dosages, which prevented us from conducting a meta-analysis.

CONCLUSION

This systematic review suggests that the results of using LLLT to improve pain and function in shoulder tendinopathies are controversial. Only 45% of the 11 studies included showed a statistically significant decrease in pain; and only 1 of the 6 studies that assessed functional outcomes observed a statistically significant improvement. Therefore, there is a need for further systematic reviews of the combined effect of LLLT and exercise, as well as of the effect of LLLT using recommended dosages in the treatment of shoulder tendinopathies.

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