The effect of low-level laser therapy and physical exercise on pain, stiffness, function, and spatiotemporal gait variables in subjects with bilateral knee osteoarthritis: a blind randomized clinical trial

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The effect of low-level laser therapy and physical exercise on pain, stiffness, function, and spatiotemporal gait variables in subjects with bilateral knee osteoarthritis: a blind randomized clinical trial

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Objective: To evaluate the effects of individual and combination therapies (low-level laser therapy and physical exercises) on pain, stiffness, function, and spatiotemporal gait variables in subjects with bilateral knee osteoarthritis (OA).

Methods: Subjects with knee OA (Grades 1–3) were evaluated and randomized into four groups: Control Group (CG), untreated; Laser Group (LG), treated with laser at 808 nm, 5.6 J; Exercise Group (EG), treated with exercise; and Laser + Exercise Group (LEG), treated with laser and exercises. The treatment was carried out twice a week for 2 months. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire was applied for evaluation and reevaluation; evaluation of spatiotemporal gait variables was performed using GAITRite equipment.

Results: The EG showed significant improvement in pain ($p = 0.006$) and function ($p = 0.01$) according to WOMAC. Regarding gait variables, in intergroup analysis after 8 weeks all groups receiving intervention showed a significant increase in gait speed: LG versus CG ($p = 0.03$); EG versus CG ($p = 0.04$) and LEG versus CG ($p = 0.005$). Only the group treated with laser + exercise showed a significant increase ($p = 0.009$) in the cadence and duration of single right limb support ($p = 0.04$), and only the groups treated with exercise and laser + exercise showed significant decreases in the duration of right limb support ($p = 0.035$ and $p = 0.003$, respectively), compared to the CG.

Conclusions: The group treated only with exercise showed improvement in WOMAC questionnaire scores. Regarding the gait variables, all groups undergoing the interventions showed increases in the gait speed compared to the CG. The laser and exercise combination therapy provided the best results for the other gait variables (cadence and duration of right limb support and duration of single right limb support).

**IMPLICATIONS FOR REHABILITATION**

- There are differences in gait patterns in patients with knee OA, including decreased gait speed, cadence, and step length.
- The results shown in the present study provide additional information about the physical therapy approaches that should be chosen during clinical practical to improve gait performance in individuals with knee osteoarthritis.
- The improvement in gait performance is a relevant issue due to the fact that it is associated to physical independence and better quality of life.

Introduction

Osteoarthritis (OA) is a musculoskeletal disease characterized by progressive reduction of the articular cartilage, new formation of subchondral bone, and osteophytes [1], causing pain, stiffness, changes in gait patterns, and decreased functional capacity [2,3].

Some studies have found differences in gait patterns in patients with knee OA, Grades 2–4, compared to healthy subjects, including decreased gait speed, cadence, and step length [4]. These changes in gait patterns can be related to the severity of the disease, pain, muscle weakness, and limited range of motion, as well as to adaptation to reduce pain [5,6]. According to Elbaz et al. [4], gait analysis has become an important method of assessing individuals with knee OA because it is an objective measure that reflects functional capacity.

Knowledge of gait characteristics in individuals in the early and intermediate stages of knee OA has an important role, because early physical therapy is possible, aiming to possibly minimize the progression of functional disability [7,8].

Several studies have reported the therapy effects for knee OA patients [9–11]. The physical exercise has positive effect on a chondroprotective anti-inflammatory cytokine response [12], reduces the pain sensitivity [13], improves physical function [14],...
The low-level laser therapy (LLLT) has been used in physical therapy for the treatment of various diseases, aiming to reduce pain, inflammation, and regeneration of damaged tissue [16,17]. In a systematic review of different therapies for individuals with knee OA, Jamtvedt et al. [18] reported that LLLT has moderate evidence for relief of pain, and therapy with exercise has high evidence of pain relief and function improvement, although there is a need for information regarding the type, frequency, and optimal dose for exercise. There are four factors that increase heterogeneity in the literature: wavelength, time of irradiation, dose, and site of application [19]. This makes clinical applications difficult, and further studies are necessary to show the effectiveness of laser for OA. Although there are studies that evaluated the association of laser and exercise on pain, stiffness, and function [16,20,21], there is need for objective assessments for function analysis, such as the spatiotemporal gait variables.

Based on studies that have reported changes in the gait parameters of subjects with knee OA, there is a need to know how much physical therapy can be beneficial for these variables (gait speed, cadence, step length, and duration of support) [4–6]. In addition, because there is controversy regarding the therapies used in these individuals, the aim of the present study was to evaluate the effects of individual and combination therapies (LLLT and physical exercises) on pain, stiffness, function, and spatiotemporal gait variables in subjects with bilateral knee OA.

**Method**

This was a clinical, therapeutic, controlled, randomized, factorial, and single-blind trial.

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**Figure 1.** Flowchart of the participation of volunteers in the study.
Sample

One hundred and twenty subjects men and women aged 40–70 years old, from Ribeirão Preto, São Paulo, Brazil, were invited to participate (Figure 1); and had received radiographic diagnosis of knee OA. For inclusion, volunteers had to have Grade 1–3 knee OA, according to the Kellgren and Lawrence (KL) classification [22].

Radiographic examination was performed at the State Hospital of Ribeirão Preto to confirm the presence of knee OA and to define the stage of OA in those who had it. The radiographic KL classification was given by the same musculoskeletal radiologist, with 20 years of professional experience, independently and blinded to clinical information.

The volunteers were evaluated by a blinded evaluator (trained and familiar with the assessment tools) and randomized into four groups: Control Group (CG) (n = 15), untreated; Laser Group (LG) (n = 15), treated with laser; Exercise Group (EG) (n = 15), treated through exercise; and Laser + Exercise Group (LEG) (n = 15), treated with laser + exercises. For randomization, a person who did not participate in the assessments or in the training program put papers with “group 1,” “group 2,” “group 3,” and “group 4” inside envelopes, scrambled the envelopes, and delivered them randomly to patients after the first evaluation. The CG was monitored about different activity or extra activity during the research, using a qualitative questionnaire with the following question: “Did you start any new physical activity in the last week?”

Exclusion criteria were: presence of cardiovascular, neurological, or musculoskeletal disease that disabled the volunteers for the performance of the exercises, uncontrolled diabetes mellitus; dizziness; evidence of secondary, inflammatory or metabolic disease; osteonecrosis and previous intra-articular injection; surgery within the 3 months prior to the study; use continuous anti-inflammatory drugs or participation in exercise therapy within the 3 months prior to the study; patients who perceive as important, whether beneficial or harmful to complete the reevaluation protocol. Therefore, the data analyses were performed using 53.58% of the initial sample allocated.

The same researcher treated all participants who received interventions.

LLLT

The volunteers were treated with low-level laser (Photon Lase III, DMC, São Carlos, Brazil), wavelength of 808 nm, 0.028 cm² spot area, 100-mW power output, fluence of 200 J/cm², energy per point of 5.6 J, in the regions of the lateral and medial epicondyle of tibia and femur, in the joint line of the lateral and medial knee, and the popliteal fossa (tendon of the biceps femoris, semitendinosus and between the tendons) and on the patellar tendon region, totaling 10 isolated points, for 56 s per point, total energy of 56 J.

Physical exercise

The exercise program included three stages of 15 supervised group sessions, with a progression of exercises in each phase (4 or 5 sessions).

The volunteers performed the exercises with supervision, following this program: (1) warm-up (5 min); 2) strengthening exercises for the lower limbs (20 min): 3 sets of 15 repetitions: flexion straight leg raise (SLR), abduction SLR, and extension SLR; (3) standing knee flexion; (4) quadriceps isometrics, 10 repetitions of 5 s, 0° and 30°; (5) aerobic exercise on a stationary bike for 20 min, starting at 65–70% of maximum heart rate (MHR) to reach 85–90% of MHR in the 5th week; (6) and stretching (5 min). In the second and third phases of the protocol, the volunteers performed functional exercises: sit and stand from a “low” chair (three sets of 10 repetitions); circuit (complete the circuit 10 times) with direction change of gait at every meter (4-m walk); overcome 4 obstacles and walk on a mat; and balance training: single-leg support (eyes open; 3 reps of 30 s on each side); balance board (both legs, 5 reps of 30 s).

Strengthening exercises of the lower limbs started at 30% of 1RM (maximum repetition) to reach 70% of 1RM in the 5th week of the protocol.

LLLT ± physical exercise

Volunteers in this group performed the exercise program followed by the application of a low-level laser.

Statistical analysis

Means and SDs for the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) questionnaire and gait variables were calculated for descriptive analysis. The Shapiro–Wilk test was used to determine the normality distribution of data. For data that did not present normal distribution, logarithmic transformation was carried out. For data with normal distribution, two-way ANOVA followed by Tukey’s post hoc test was used to determine possible differences between groups. The minimal important difference (MID) has been defined as “the smallest difference in scores in the domain of interest that patients perceive as important, whether beneficial or harmful” [27]; this is important to clinicians, since it can help guide treatment decisions. The MID was determined by multiplying the effect size (ES) of the difference between groups considered important (0.2 and 0.5 according to Cohen) by the pooled SD baseline between two groups [28]. A mean difference between groups that is higher than the MID can be considered clinically relevant (CR) [28,29]. A value of p < 0.05 was used as the significance level for all tests. The criteria for scores are as follows. When both the ES and the mean
differences between groups are higher than both MIDs, then scored CR. If the ES is moderate and one of the MIDs is reached, scored potentially clinically relevant (PCR). If both ES and MIDs are not accomplished or a clinical criterion determines NCR, then scored NCR. ESs are described according to Cohen: small ES (SES) = 0–0.19; medium ES (MES = 0.2–0.59); large ES (LES) = 0.6–1.99.

Calculation of the sample size of a total of 60 participants, 15 per group, was based on average and SD of gait speed of a pilot study, power of 0.80 and alpha level of 0.05, through G*Power Software, version 3.1.92 (Universitat Kiel, Kiel, Germany). All the statistical analyses were carried out using SPSS (Version 16, SPSS Inc., Chicago, IL, USA).

Results

Anthropometric data are presented in Table 1. The groups were homogeneous for height and age.

WOMAC questionnaire

At baseline, the groups did not differ in WOMAC scores.

In the intragroup analysis, only the EG showed significant differences in subscales on the WOMAC questionnaire: pain ($p = 0.006$), function ($p = 0.01$), and total WOMAC score ($p = 0.01$) after 8 weeks of intervention. The other groups showed no significant differences after 8 weeks (Table 2).

In the intergroup analysis, there were no significant differences after 8 weeks of treatment.

Gait evaluation

In the intergroup analysis, at baseline, there were no significant differences for any variables of the evaluated gait.

Gait speed

In the intragroup analysis, there were no significant differences between the groups.

In the intergroup analysis, after 8 weeks, there was an increase in gait speed when comparing the LG and the CG ($p = 0.03$); EG and CG ($p = 0.04$); and LEG and CG ($p = 0.005$) (Table 3). The comparisons of the three groups were CR (Table 4).

Cadence

In the intragroup analysis, no significant differences among the groups were observed.

Table 1. Mean (SD) of age, weight, height, and BMI of groups.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Age (years)</th>
<th>Gender</th>
<th>Weight (kg)</th>
<th>Height (m)</th>
<th>BMI (kg/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group, $N = 15$</td>
<td>60.8 (9.2)</td>
<td>3 Men 12 Women</td>
<td>79.47 (17.34)</td>
<td>1.59 (0.09)</td>
<td>31.52* (6.97)</td>
</tr>
<tr>
<td>Laser Group, $N = 15$</td>
<td>58.20 (7.97)</td>
<td>2 Men and 13 Women</td>
<td>82.45* (12.34)</td>
<td>1.61 (0.09)</td>
<td>31.57* (3.58)</td>
</tr>
<tr>
<td>Exercise Group, $N = 15$</td>
<td>58.57 (7.42)</td>
<td>5 Men and 10 Women</td>
<td>78.71 (14.02)</td>
<td>1.64 (0.10)</td>
<td>29.28 (4.72)</td>
</tr>
<tr>
<td>Laser + Exercise Group, $N = 15$</td>
<td>64.5 (5.24)</td>
<td>3 Men and 12 Women</td>
<td>66.75 (12.51)</td>
<td>1.59 (0.07)</td>
<td>26.52 (4.43)</td>
</tr>
</tbody>
</table>

*p < 0.05 according to Tukey’s test.

Table 2. Mean and SD of scores on WOMAC questionnaires by group (total, pain, stiffness, and function).

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group ($N = 15$)</td>
<td>15.20 (21.73)</td>
<td>12.16 (15.8)</td>
<td>6.57 (10.03)</td>
<td>1.64 (0.10)</td>
<td>31.57 (2.22)</td>
<td>29.28 (4.72)</td>
<td>18.33 (2.30)</td>
<td>15.83 (2.30)</td>
</tr>
<tr>
<td>Exercise Group ($N = 15$)</td>
<td>17.08 (22.07)</td>
<td>15.24 (17.34)</td>
<td>8.00 (10.09)</td>
<td>3.12 (0.12)</td>
<td>31.57 (2.22)</td>
<td>29.28 (4.72)</td>
<td>18.33 (2.30)</td>
<td>15.83 (2.30)</td>
</tr>
<tr>
<td>Laser + Exercise Group ($N = 15$)</td>
<td>18.33 (20.67)</td>
<td>16.84 (19.87)</td>
<td>9.82 (12.34)</td>
<td>3.90 (0.12)</td>
<td>31.57 (2.22)</td>
<td>29.28 (4.72)</td>
<td>18.33 (2.30)</td>
<td>15.83 (2.30)</td>
</tr>
</tbody>
</table>

*p < 0.05 versus pre-Exercise Group, intragroup comparison according to the Wilcoxon test.

Table 3. Means (SD) of gait variables (speed, cadence, step length, duration of the support phase, and duration of the single support phase).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Speed (m/s)</th>
<th>Cadence (steps/min)</th>
<th>Step length (cm)</th>
<th>Stance % of cycle L</th>
<th>Step length (cm)</th>
<th>Stance % of cycle R</th>
<th>Single support % cycle L</th>
<th>Single support % cycle R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group ($N = 15$)</td>
<td>1.03 (0.16)</td>
<td>1.15 (0.18)</td>
<td>1.14 (0.15)</td>
<td>1.19 (0.21)</td>
<td>1.14 (0.15)</td>
<td>1.18 (0.14)</td>
<td>62.81% (1.71)</td>
<td>62.97% (1.71)</td>
</tr>
<tr>
<td>Laser Group ($N = 15$)</td>
<td>1.06 (0.13)</td>
<td>1.15 (0.18)</td>
<td>1.14 (0.15)</td>
<td>1.19 (0.21)</td>
<td>1.14 (0.15)</td>
<td>1.18 (0.14)</td>
<td>62.81% (1.71)</td>
<td>62.97% (1.71)</td>
</tr>
<tr>
<td>Laser + Exercise Group ($N = 15$)</td>
<td>1.06 (0.13)</td>
<td>1.15 (0.18)</td>
<td>1.14 (0.15)</td>
<td>1.19 (0.21)</td>
<td>1.14 (0.15)</td>
<td>1.18 (0.14)</td>
<td>62.81% (1.71)</td>
<td>62.97% (1.71)</td>
</tr>
<tr>
<td>Control Group ($N = 15$)</td>
<td>106.93 (7.06)</td>
<td>112.06 (12.6)</td>
<td>112.55 (9.67)</td>
<td>118.60 (7.58)</td>
<td>112.55 (9.67)</td>
<td>118.60 (7.58)</td>
<td>61.41 (4.2)</td>
<td>61.41 (4.2)</td>
</tr>
<tr>
<td>Laser Group ($N = 15$)</td>
<td>105.45 (6.38)</td>
<td>115.12 (11.33)</td>
<td>112.55 (9.67)</td>
<td>118.60 (7.58)</td>
<td>112.55 (9.67)</td>
<td>118.60 (7.58)</td>
<td>61.41 (4.2)</td>
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</tr>
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<td>105.45 (6.38)</td>
<td>115.12 (11.33)</td>
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<td>118.60 (7.58)</td>
<td>61.41 (4.2)</td>
<td>61.41 (4.2)</td>
</tr>
</tbody>
</table>

*p < 0.05 versus Control Group, according to Tukey’s test.

*p < 0.05 versus baseline, according to Tukey’s test, intragroup evaluation.
In the intergroup analysis, after 8 weeks, there was significant difference and CR cadence only in the comparison between the LEG and the CG (0.009) (Tables 3 and 4).

**Length of the left and right step**

Intragroup and intergroup analyses showed no significant differences between groups and after 8 weeks for left and right step length (Table 3).

**Duration of left and right support (percentage value of the gait cycle)**

For the duration of the left support phase, intragroup and intergroup analyses showed no statistical differences.

For the duration of the right support phase, in the intragroup analysis, all groups receiving intervention (laser, exercise, and laser + exercise) showed significant decreases in this variable ($p = 0.014$, $p = 0.011$, $p = 0.035$).

In the intergroup analysis, only the groups treated with exercise and laser + exercise showed significant decreases ($p = 0.035$ and $p = 0.003$, respectively) and PCR compared to the CG after 8 weeks.

**Duration of single right and left support (percentage value of the gait cycle)**

In the intragroup analysis, there were no significant differences between the groups for the duration of the single right and left support phase.

Regarding the intergroup analysis, no significant difference between the groups was observed for the duration of the single left support phase. For the duration of the single right support phase, only the group treated with laser + exercise showed a significant increase ($p = 0.04$) and PCR when compared to the CG after 8 weeks.

**Discussion**

Investigating intervention strategies that are beneficial for the improvement of symptoms associated with OA and improved function is relevant for clinical practice, since the presence of physical and functional impairments negatively affect the quality of life of this population.

Therefore, the present study investigated the effects of low-level laser alone and combined with exercise on pain, stiffness, and function, assessed by WOMAC questionnaire, and spatiotemporal gait variables of subjects with knee OA.

The WOMAC questionnaire is one of the self-report questionnaires most used to evaluate lower limb symptoms and function [30,31]. According to Herman and Khosla [32], LLLT acts on the tissue, improving oxygen supply, releasing neurotransmitters associated with pain modulation, and releasing anti-inflammatory mediators. The present study included patients with knee OA up to Grade 3, and all participants had mean WOMAC questionnaire total scores and subscale scores (pain, stiffness, and function) classified as mild (<25 points), it could be a possible explanation for the groups that received LLLT treatment not showing significant decreases in WOMAC scores. The population in the initial stages of the current study was chosen in order to evaluate the effects of intervention and prevention of functional worsening as observed in this population of patients with knee OA.

According to Serrão et al. [30], rehabilitation programs that include strengthening of the quadriceps muscle are indicated for patients in the early stages of knee OA to improve muscle strength, reduce pain, and improve function. The present study
corroborates the study by Serrão et al. [30] because the proposed treatment included exercises for quadriceps strengthening, and the subjects in the EG showed significant improvements in pain and function as measured the WOMAC questionnaire scores.

A prospective, descriptive study by Solimanpour et al. [17] evaluated the effects of LLLT (810 nm, dose 6 J/cm², 3 times a week for 12 sessions), applied on six areas of the knee (above, in the middle and below the kneecap) in subjects with history of knee OA for more than a year. The results showed that the laser reduced nocturnal pain, and pain when walking and climbing stairs. A systematic review study [33] on the effects of laser in subjects with knee OA, concluded that LLLT did not show effectiveness based on the WOMAC questionnaire (pain, stiffness, and function) after 12 weeks of treatment and after LLLT. The present study corroborates the Huang et al.’s [33] study, since the groups that received LLLT treatment (both LG and LEG) showed no significant improvements in pain and function as measured by the WOMAC questionnaire.

Alfredo et al. [21] compared the effects of combined therapies in subjects with knee OA (2–4 stages). The subjects were divided into two groups: LLLT + exercises and LLLT placebo + exercises. The knees were irradiated with lasers at 5 points on the joint line of the synovial region and at 4 points in the side regions of the knee, 3 J per point, totaling 27 J per session. The intervention was performed 3 times a week for 8 weeks. The authors concluded that LLLT combined with exercise was effective in relieving pain (assessed by a visual analog scale and WOMAC) and improved function (assessed by the Lequesne and WOMAC questionnaires) in patients with knee OA. In the present study, combination therapy showed no significant improvement in relation to pain and function as assessed by the WOMAC questionnaire, but showed benefits in the gait variables of speed, cadence, duration of the right support phase, and duration of single right support. An important issue to be considered is the heterogeneity of LLLT parameters (wave length, power, dose, and time of application). According to Meneses et al. [9], this variability in the literature is a possible source of controversy about laser use.

Bennell et al. [34] reported the suggested principles of exercise prescription for knee OA based on current evidence about physical therapy, and they concluded that to reduce pain and improve function, exercises can be performed both in water and on the ground; a combination of exercises should be performed in order to improve function, aerobic capacity and flexibility; focus on quadriceps strengthening; exercises can be performed individually or supervised, in a group or at home; at least 12 supervised sessions should be performed; and frequency should be 3 times a week or more. In the present study, the exercise protocol followed in part the recommendations of Bennell et al. [34]: It included 15 supervised sessions, in a group; and it was carried out for 8 weeks, with progression of the exercises every 4 sessions. It differed only in frequency, because it was done twice a week. The results of the present study corroborate the study by Bennell et al. [34] because when compared to pretreatment, the group treated only with exercise showed a decrease in pain and improved function shown by WOMAC questionnaire, such as: walking up and down stairs; getting up from sitting; bending down to pick up something; getting in and out of a car; and walking.

According to Elbaz et al. [4] many studies have focused on relieving symptoms of patients with OA, which is usually reported using self-report questionnaires. Since these questionnaires are subjective, an objective assessment tool is needed to help assess the symptoms. It has recently been suggested that computerized gait analysis could be a good indicator of functional severity [4].

**Gait impact on knee OA subjects**

Subjects with knee OA can make adaptations in gait due to pain and deformities, such as decreasing gait speed, cadence, step length, and the single support phase [35], which can also damage the spine and other joints of the lower limbs. These adaptations are related to the severity of the disease, pain, muscle weakness, and decreases in range of motion.

According to White et al. [36], the most common cause of walking difficulties is knee OA, which leads to a decrease in gait speed. Evaluation of gait speed allows prediction of the risk of physical disability, falls and other adverse events in the elderly, with a speed greater than 1.2 m/s predicting high life expectancy [37,38]. Cesari et al. [38] observed that symptomatic OA is a risk factor for premature decline of gait speed, regardless of age, and a decrease in mobility can occur, inducing a vicious cycle that reduces physical activity, leading to physical deconditioning, which has a direct effect on health.

In the present study, all groups receiving interventions showed significant and CR increases in gait speed compared to the CG. Regarding cadence, only the LEG showed significant and CR increases compared to the CG after 8 weeks.

Novaes et al. [39] evaluated the gait speed of middle-aged and elderly Brazilians and observed an average speed for individuals aged 50–59 years of 1.34 m/s for men and 1.27 m/s for women, and for individuals aged 60–69 years of 1.26 m/s for men and 1.07 m/s for women. In the present study, the average speed of the subjects (men and women) at baseline was 1.12 m/s, with the average age of these subjects being 60 years, thus showing an average speed below that of the healthy subjects assessed by Novaes et al. [39]. After 8 weeks, the average gait speed of patients who received treatment in our study was 1.19 m/s and of the CG was 1.0 m/s.

The increase in the support phase represents an abnormal gait pattern that usually characterizes individuals with knee OA [4,5]. In the current study, the groups that received interventions showed significant decreases in the right support phase in the intragroup evaluation. In the intergroup evaluation, after 8 weeks, only groups treated with exercise and laser + exercise showed significant and potentially relevant decreases in the duration of right support phase compared to the CG. The present study corroborates the study by Elbaz et al. [4] who also observed a decrease in the double support phase and increased gait speed after intervention with noninvasive biomechanics therapy indicating a positive effect after intervention.

In the single support phase, when the body weight is on only one limb while the contralateral limb is in the swing phase, accounting for about 38–40% of the gait cycle [40,41], only the LEG showed a significant increase in the duration of the right single support phase compared to the CG after 8 weeks. According to Elbaz et al. [40], the duration of the single limb support phase may reflect the individual's ability to bear loads on the support limb, and an individual with severe pain and decreased function will probably decrease load bearing on the affected limb, decreasing the single limb support phase in the gait. And a strong association was observed between the duration of the single limb support phase and the severity of knee OA, concluding that low duration of the single limb support phase mean worsening of symptoms of knee OA, pain, function, and quality of life.

Spatiotemporal gait variables have clinical relevance in evaluating diseases, mainly orthopedic. Patients with knee OA can adapt their gait in response to pain and deformity of the joints of the lower extremities. These individuals often adopt a type of antalgic gait as their disease progresses; this adaptation can affect the
natural mobility of the lumbar spine, causing pain [5]. Therefore, early intervention for these patients, with the objective of preventing gait changes or improving what is already damaged, would be very important in maintaining the individual’s function and quality of life.

Physical exercise is beneficial for individuals with knee OA, because it helps in pain relief, flexibility, aerobic capacity, and gait parameters [18,42]. Laser has an analgesic, anti-inflammatory effect and improves joint stiffness, swelling, and function [43–45]. The authors of the present study believe that the analgesic and anti-inflammatory effects of LLLT, along with the effects of exercise in improving pain and function, may have provided the best results for the gait variables analyzed in this study, more than the use of therapies alone.

Conclusion

The group treated only with exercise showed improvements in pain and function as shown by decreasing WOMAC questionnaire scores (total and subscales: pain and function).

Regarding gait speed, all groups that underwent interventions showed increases in this parameter compared to the CG, and therapy combining laser and exercise provided the best results for the other gait variables (cadence and duration of right support and duration of the right single support phase).

Disclosure statement

The authors report no declarations of interest.

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