Hydrotherapy Versus Conventional Land-Based Exercise for the Management of Patients With Osteoarthritis of the Knee: A Randomized Clinical Trial

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Background and Purpose

This study was designed to evaluate the effectiveness of hydrotherapy in subjects with osteoarthritis (OA) of the knee compared with subjects with OA of the knee who performed land-based exercises.

Subjects and Methods

Sixty-four subjects with OA of the knee were randomly assigned to 1 of 2 groups that performed exercises for 18 weeks: a water-based exercise group and a land-based exercise group. The outcome measures included a visual analog scale (VAS) for pain in the previous week, the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), pain during gait assessed by a VAS at rest and immediately following a 50-foot (15.24-m) walk test (50FWT), walking time measured at fast and comfortable paces during the 50FWT, and the Lequesne Index. Measurements were recorded by a blinded investigator at baseline and at 9 and 18 weeks after initiating the intervention.

Results

The 2 groups were homogenous regarding all parameters at baseline. Reductions in pain and improvements in WOMAC and Lequesne index scores were similar between groups. Pain before and after the 50FWT decreased significantly over time in both groups. However, the water-based exercise group experienced a significantly greater decrease in pain than the land-based exercise group before and after the 50FWT at the week-18 follow-up.

Discussion and Conclusion

Both water-based and land-based exercises reduced knee pain and increased knee function in participants with OA of the knee. Hydrotherapy was superior to land-based exercise in relieving pain before and after walking during the last follow-up. Water-based exercises are a suitable and effective alternative for the management of OA of the knee.

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Osteoarthritis (OA) is a chronic disease characterized mainly by complex, multifactorial joint degeneration. The prevalence of OA increases with age and eventually leads to joint stiffness, progressive deformity, and functional impairment, which, in turn, negatively affect the individual's quality of life.[1] In recent years, the increase in the elderly population has been accompanied by a proportional increase in the number of people with OA.[2–4]

There is evidence indicating that land-based exercises can be beneficial for people with OA of the knee by reducing pain and improving global function. These exercises have been recommended in 2 guidelines.[5,6] A systematic literature review[7] has shown that regular physical exercise is associated with significant improvement in the functional capacity of people with OA of the knee. Measurements of chondroitin sulfate in the synovial fluid have indicated that exercise causes no significant harm to people with OA of the knee.[8] In another systematic review of randomized controlled trials, the authors[9] suggested that aerobic and strengthening exercises are effective in reducing pain and disability in such patients.

Aquatic exercises have been widely used in physical therapy programs, especially when exercising under normal conditions of gravity is difficult and painful.[10,11] Water buoyancy reduces the weight that joints, bones, and muscles have to bear. The warmth and pressure of the water also reduce swelling and increase blood circulation.[12] Consequently, an underwater environment allows early active mobilization and dynamic strengthening.[12–14]

In a study comparing the benefits of therapeutic knee exercise underwater and on dry land in people who were healthy, Tapani et al[11] concluded that drag underwater provided specific stimulation, thereby enhancing functional capacity. The authors recommended considering the hydrodynamic forces that influence the exercising limb in order to ensure adequate progression through the exercises. However, as the exercises in the study were performed in only a sitting position, the results should be generalized cautiously.

In another study investigating the effects of a progressive 10-week aquatic resistance training program in women who were healthy, Tapani et al[15] observed improvement in the static and dynamic torque of the knee extensors and flexors as well as an increase in muscle activity and a gain in the lean muscle mass of the quadriceps femoris and hamstring muscles. The authors suggested aquatic resistance training as an appropriate option for individuals with a limited capacity for exercising on dry land.

To our knowledge, only one study[16] has evaluated the effectiveness of hydrotherapy exercise for the management of OA of the knee in comparison with land-based exercises. The authors demonstrated that both exercise modalities were equally effective in improving strength (force-generating capacity) and physical function. However, the sample was composed of patients with knee or hip OA, which impedes the determination of the effects on patients with only OA of the knee. Moreover, the study used a 6-week exercise program, which may not have allowed sufficient time to produce changes in strength or physical function. There have been few nonrandomized studies on the use of hydrotherapy for the management of OA of the knee.[17–19] Thus, the aim of the present study was to investigate the therapeutic effectiveness of hydrotherapy in subjects with OA of the knee and compare the outcome with that obtained using conventional land-based exercises.

Method

Subjects

Patients with OA of the knee were selected from the Rheumatology Outpatient Clinics at São Paulo Hospital (Universidade Federal de São Paulo/Escola Paulista de Medicina [UNIFESP/EPM]) and were invited to participate in this study. Inclusion criteria included clinical and radiographic diagnosis of OA of the knee according to the American College of Rheumatology criteria[20] and knee pain ranging from 30 to 90 mm on a visual analog scale (VAS). The minimum and maximum inclusion values for pain (30 and 90 mm) were chosen to detect clinically relevant improvements and avoid regression to the mean. All of the participants gave written informed consent prior to being enrolled in the study.

Patients were excluded if they had neurological diseases of the lower limbs, symptomatic heart disease, symptomatic disease affecting the extremities other than OA of the knee, symptomatic lung disease, severe systemic disease that could interfere with the assessments, psychiatric disorder, epilepsy, skin disease, or an inability to walk. Patients who received intra-articular injections of steroids in the preceding 3 months and those who had physical therapy intervention for their knee in the preceding 6 months or practiced regular physical activity (3 times a week or more) for more than 1 month also were excluded.

Randomized allocation into either a land-based exercise group or a water-based exercise group was done by drawing lots. The participants were evaluated before intervention (baseline or T0), at 9 weeks after initiating the intervention (T9), and at 18 weeks after initiating the intervention (the end of the protocol or T18). A single, blinded investigator performed all pain, function, and gait evaluations. Participants with poor adherence to the program (defined as missing more than 2 consecutive sessions or more than 20% of all sessions) were excluded from the exercise program, but their data were used in the statistical analysis.

Measurements

The primary outcome measure was pain in the previous week, assessed using a 100-mm VAS for pain. This is a valid, reliable, and responsive technique for assessing pain in people with OA.[21]

The secondary outcome measures included:

1. The Lequesne Index for OA of the knee, which evaluates pain or discomfort, maximum distance walked, and activities of daily living. Scores range from 0 to 24, with higher scores indicating greater disease severity. The Lequesne Index questionnaire is well recognized for its adequate validity, reliability, and responsiveness for individuals with OA of the knee.[22]

2. The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), which consists of 3 subscales: pain, stiffness, and physical function. Scores range from 0 to 96, with higher scores indicating greater disease severity. The WOMAC questionnaire is well recognized for its adequate validity, reliability, and responsiveness for individuals with OA of the knee.[23]

3. Pain during gait, assessed by a 100-mm VAS at rest and immediately following a 50-foot (15.24-m) walk test (50FWT).[24]

4. The walking time measured at fast and comfortable paces during the 50FWT.

5. The number of nonsteroidal anti-inflammatory drugs (NSAIDs) used. The NSAID used during the study was sodium diclofenac (50-mg tablets). Participants were asked to keep a daily record of their NSAID use. The mean number of sodium diclofenac tablets used monthly then was calculated for each group.

Intervention

The water-based and land-based exercises were performed in groups of 5 to 8 participants. The groups were instructed by 2 trained physical therapists who were randomly assigned to the groups. Physical therapist crossover between groups occurred every week to ensure that both physical therapists instructed the 2 groups throughout the protocol. Participants were instructed to take 50-mg sodium diclofenac tablets as needed, not surpassing a maximum dose of 150 mg per day.

The water-based exercise group underwent supervised water exercise sessions in a heated (32°C) pool (120-cm deep), and the land-based exercise group underwent supervised land-based exercise sessions in a room with mats and a walkway. The same types of exercise were used for both groups. Land-based exercises were adapted to be performed underwater in order to exercise the same muscles. The exercises used for both groups included stretching and strengthening of the major muscle groups of the lower extremities, along with gait training. Both groups had 50-minute training sessions 3 times a week for 18 weeks.

Two repetitions of each static stretching exercise were performed per muscle group, with each repetition lasting 20 seconds. Isometric strengthening involved 7 to 10 repetitions, with contraction maintained for 6 seconds. Isotonic strengthening exercises were performed with 20 to 40 repetitions, and load was applied as follows. In the first week of adaptation to the program, the participants performed 20 repetitions without extra resistance. In the second and third weeks, they performed 20 repetitions, with extra resistance provided by elastic bands or by 1-kg ankle weights in the land-based exercise group and by floaters and increased speed in the water-based exercise group. After four weeks, resistance was maintained and the number of repetitions was increased to 40. This number of exercise repetitions was chosen based on a study by Deyle et al[25] in which each set of exercises was done in 30 seconds, corresponding to the time that the participants in the present study usually took to do each of the 40 repetitions. Gait was trained in 10-minute sessions. Table 1 summarizes the exercise protocol for each group.

Data Analysis

Sample size was calculated using a VAS for pain as the main parameter. With 64 participants, our study had an 80% power to detect a change in pain of 17.5 mm between the water-based and land-based groups. The significance level was set at .05, with β=20%.

Categorical baseline variables were analyzed using the chi-square test, and continuous baseline variables were analyzed using an independent-sample *t* test or the Mann-Whitney *U* test in the case of data with a skewed distribution. The outcomes were analyzed according to the intention-to-treat principle. We used a 2-way, repeated-measures multiple regression analysis of variance (ANOVA) with Tukey *post hoc* test, with intervention (water-based exercise versus land-based exercise) as the between-subject variable and time (T0, T9, and T18) as the within-subject variable. The dependent variables analyzed were pain in the previous week, Lequesne Index and

Table 1.
Description of Exercises Performed During the Intervention Period[21–23]

Land-Based Exercises	Water-Based Exercises
Stretching:	Stretching:
In a sitting position, cross one leg over the other and place one hand on top of the foot to grasp the toes; pull and hold for 20 s	In a sitting position, with your back against the side of the pool, cross one leg over the other and place one hand on top of the foot to grasp the toes; pull and hold for 20 s
In a supine position, with the knees flexed so that the feet are resting comfortably in a flat position, raise the exercise limb with the knee in full extension using a band around the foot to maintain dorsiflexion; hold the stretch for 20 s	In a sitting position, with your back against the side of the pool, straighten one knee using a band to raise the foot in dorsiflexion and hold for 20 s
Lying on your side with the exercise limb on top, keep both knees together and the lower leg straight; bend the top knee by grasping the foot with the hand; bring the heel as close to the buttocks as possible; hold the stretch for 20 s	In a standing position, holding onto the edge of the pool, bend one knee (heel up toward buttocks), hold the raised foot with one hand, and gradually push the pelvis forward, holding for 20 s
	In a sitting position, with your back against the side of the pool, straighten one knee using a band to raise the foot in dorsiflexion and slowly move the foot outward to the side, holding for 20 s
Isometric strengthening:	Isometric strengthening:
In a supine position, with the knees straight, perform dorsiflexion and hold for 6 s	In a supine position, with cervical and pelvic floaters, perform dorsiflexion and hold for 6 s
In a supine position, with the knees straight, perform plantar flexion and hold for 6 s	In a supine position, with cervical and pelvic floaters, perform plantar flexion and hold for 6 s
Isotonic strengthening:	Isotonic strengthening:
In a supine position, with the knees flexed so that the feet are resting comfortably in a flat position and with the hands resting by your sides, raise the midsection to make a straight line through your knees, hips, and shoulder (bridge); extra resistance provided by 1-kg ankle weights	In a standing position in front of the wall, hold the wall with your hands, lift the leg backward to a comfortable height; return and repeat with the other leg; extra resistance provided by floaters and increased speed
In a supine position, with both legs resting on a triangular support and the knees flexed at a 30° angle, straighten one leg; return and repeat with the other leg; extra resistance provided by 1-kg angle weights	In a standing position, with your back against the side of the pool, slowly lift the leg straight forward to a comfortable height; return and repeat with the other leg; extra resistance provided by floaters and increased speed
In a supine position and the contralateral limb knee flexed so that the foot is resting comfortably in a flat position, raise the exercise limb with the knee in full extension to the height of the contralateral flexed knee, then lower the limb back to the initial position; extra resistance provided by 1-kg ankel weights	In a supine position, with certival and pelvic floaters, bend and straighten the knees with sustained dorsiflexion; extra resistance provided by floaters and increased speed
Lying flat on your back with both legs straight, place an elastic band around the thighs just above the knees and perform thigh abductions; extra resistance provided by eleastic bands	In a supine position, with cervical and pelvic floaters, perform abduction and adduction of the thighs with sustained dorsiflexion; extra resistance provided by floaters and increased speed
Lying flat on your back with both legs straight, place a ball between the knees and perform thigh adductions; extra resistance provided by 1-kg ankle weights	In a sitting position, with floaters under the arms, straighten the knee with the foot in dorsiflexio and bend the knees with the foot in plantar flexion while moving forward in the pool; extra resistance provided by floaters and increased speed
Lying sideways, bend the knee and hip of the lower leg and raise the upper leg, keeping it straight; extra resistance provided by 1-kg ankle weights	In a sitting position, with floaters under the arms, straighten the knee with the foot in plantar flexion and bend the knees with the foot in dorsiflexion while moving backward in the pool; extra resistance provided by floaters and increased speed
In a supine position, with the knees flexed so that the feet are resting comfortably in a flat position and with hands on your thighs, slowly slide the hands along your leg up toward your knees and bring your shoulders and head up; extra resistance provided by 1-kg angle weights	In a standing position, rise up on your toes and return; extra resistance provided by the increased speed

(Continued)

Table 1.
Continued

Land-Based Exercises	Water-Based Exercises
In a prone position, slowly pull one heel toward the buttocks; return and repeat with the other leg; extra resistance provided by 1-kg ankle weights In a standing position, rise up on your toes and return; extra resistance provided by 1-kg ankle weights	Gait training: Forward walking with alternated movement of the upper and lower extremities Walk raising the knee Lateral walking Backward walking
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WOMAC scores, time to complete the 50FWT at a fast pace, time to complete the 50FWT at a comfortable pace, pain before the 50FWT, pain after the 50FWT, and NSAID use. When significant intergroup differences were detected by the ANOVA, a paired *t* test was used to assess intragroup differences at T0, T9, and T18.

Results

Sixty-four participants were included in the study. Thirty-two participants (30 female, 2 male) were randomly assigned to the water-based exercise group, and 32 participants (29 female, 3 male) were randomly assigned to the land-based exercise group. Table 2 displays the characteristics of both groups. The 2 groups did not differ significantly at baseline regarding demographic characteristics and disease-related parameters.

A total of 57 participants concluded the protocol. In the water-based exercise group, 31 of the 32 participants (96%) concluded the protocol. The only dropout in this group was due to work-related problems. In the land-based exercise group, 26 of the 32 participants (81%) concluded the study, with 6 dropouts. Three participants discontinued the protocol in the 1st week because they did not like being randomly allocated to the land-based exercise group; another participant also dropped out in the 1st week because of transportation problems that impeded adherence to

Table 2.
Baseline Demographic Characteristics and Disease-Related Parameters in Participants With Osteoarthritis of the Knee[a]

Parameter	Water-Based Exercise Group (n=32)	Land-Based Exercise Group (n=32)	*P*
Age (y)	59 (7.60)	59 (6.08)	.80
Height (cm)	153 (4.36)	153 (6.97)	.90
Body weight (kg)	75 (11.87)	76 (12.89)	.60
VAS for pain (mm)	61.9 (15.7)	68.2 (15.5)	.25
Sodium diclofenac (50-mg tablets/mo)	31.63 (19.79)	31.11 (19.78)	.98
Lequesne Index	11.96 (3.82)	12.24 (3.78)	.64
WOMAC	32.86 (13.99)	34.92 (12.62)	.45
50FWT, comfortable pace (s)	12.94 (15.12)	13.19 (15.57)	.67
50FWT, fast pace (s)	8.71 (10.33)	8.58 (10.34)	.98
VAS for pain before the 50FWT (mm)	39.6 (23.4)	53.0 (24.4)	.12
VAS for pain after the 50FWT (mm)	48.2 (25.6)	61.1 (19.6)	.12

[a] Results expressed as the mean with standard deviation in parentheses. VAS=visual analog scale, 50FWT=50-ft (15.24-m) walk test, WOMAC=Western Ontario and McMaster Universities Osteoarthritis Index.

Table 3.
Visual Analog Scale (VAS) Scores for Pain in Previous Week, Lequesne Index Scores, and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) Scores for Participants With Osteoarthritis of the Knee at 0 Weeks (T0), 9 Weeks (T9) and 18 Weeks (T18) After Intervention

	Water-Based Exercise Group (n=32)	Land-Based Exercise Group (n=32)	*P* (Intergroup)
	Mean±SD (95% CI[a])	Mean±SD (95% CI)	
VAS (mm)			
T0	61.9±15.7 (56.2–67.5)	68.2±15.5 (62.1–74.4)	.198
T9	37.0±18.1 (28.8–45.3)	38.4±27.5 (29.4–47.4)	
T18	26.7±23.1 (17.7–38.5)	37.3±27.5 (27.3–47.2)	
P (intragroup)	<.001[b]	<.001[b]	
Lequesne Index			
T0	11.96±3.82 (10.65–13.27)	12.24±3.78 (10.95–13.53)	.33
T9	8.06±3.37 (6.91–9.21)	8.80±4.96 (7.1–10.5)	
T18	6.70±4.21 (5.25–8.15)	8.64±5.48 (4.82–8.58)	
P (intragroup)	<.001[b]	<.001[b]	
WOMAC			
T0	32.86±13.99 (28.12–37.8)	34.92±12.62 (30.55–39.29)	.18
T9	18.80±13.37 (14.18–23.42)	23.64±17.95 (17.43–19.85)	
T18	15.56±12.55 (11.23–19.89)	22.68±18.34 (16.33–29.03)	
P (intragroup)	<.001[b]	<.001[b]	

[a] CI=confidence interval.
[b] *P* value statistically significant.

the protocol; 1 participant had fibromyalgia, which was diagnosed in the 4th week; and 1 participant had to leave São Paulo due to personal problems in the 13th week. Data for all 64 patients were included in the analysis (intention-to-treat) by carrying the last available score forward.

There was no significant difference in pain in the previous week (P=.198) between groups. However, intragroup comparisons (Tab. 3) revealed that participants in both groups experienced significant reductions in pain in the previous week over time (P<.001).

Mean Lequesne Index scores were not significantly different between groups (P=.333) (Tab. 3). Intragroup analyses of this parameter demonstrated a significant improvement in both groups between T0 and T9 (P<.001) and only for the water-based exercise group between T9 and T18 (P<.001). Accordingly, there was no significant intergroup difference in the WOMAC scores (P=.185). As with the Lequesne Index scores, there was a significant reduction in the WOMAC scores between T0 and T9 for both groups.

After intervention, the water-based exercise group exhibited significant decreases in pain (measured by VAS) before (P=.04) and after (P=.02) the 50FWT compared with the land-based exercise group (Tab. 4). Intergroup comparisons over time revealed significant differences in pain before (P=.009) and after (P<.000) the 50FWT only at T18, with the water-based exercise group improving more than the land-based exercise group (Figure). Intragroup comparisons revealed significant reductions in pain before and after the 50FWT in both groups, with these differences occurring between T0 and T9 and between T0 and T18; there was no significant difference between T9 and T18 in either group.

Table 5 also displays significant intragroup differences for walking at a comfortable pace in the 50FWT at T0, T9, and T18 (P<.001), again suggesting that both interventions improved the participants' physical performance. For the fast pace in the 50FWT, this difference was observed between T0 and T9 in the land-based exercise group (P<.001) and between T9 and T18 in the water-based exercise group.

The use of sodium diclofenac did not differ significantly between groups (Tab. 5). Intragroup analyses re-

Table 4.
Visual Analog Scale (VAS) Scores for Pain Before and After the 50-foot (15.24-m) Walk Test (50FWT) in Participants With Osteoarthritis of the Knee at 0 Weeks (T0), 9 Weeks (T9), and 18 Weeks (T18) After Intervention

	Water-Based Exercise Group (n=32)	Land-Based Exercise Group (n=32)	*P* (Intergroup)
	Mean±SD (95% CI[a])	Mean±SD (95% CI)	
VAS for pain before 50FWT (mm)			
T0	39.6±23.4 (31.0–48.1)	53.0±24.4 (43.6–62.4)	.045[b]
T9	21.7±20.7 (13.0–30.5)	26.5±28.1 (16.9–36.1)	
T18	14.8±21.4 (5.4–24.2)	28.8±30.8 (18.5–39.1)	
P (intragroup)	<.001[b]	<.001[b]	
VAS for pain after 50FWT (mm)			
T0	48.2±25.6 (39.9–56.5)	61.1±19.6 (52.0–70.2)	.028[b]
T9	25.4±22.3 (16.3–34.6)	30.3±28.4 (20.4–40.3)	
T18	15.1±19.8 (5.8–24.4)	33.4±31.7 (23.2–43.6)	
P (intragroup)	<.001[b]	<.001[b]	

[a] CI=confidence interval.
[b] *P* value statistically significant.

vealed that NSAID use was reduced by the third month in both groups and again in the fourth month only in the water-based exercise group.

Discussion and Conclusions

Our findings demonstrated that both water-based and land-based exercises reduced pain and improved function in individuals with OA of the knee. Pain is an important symptom in patients with OA of the knee. Thus, a main goal of any therapeutic intervention should be to reduce this clinical component of the disease. In a systematic review,[5] the European League Against Rheumatism (EULAR) found that a VAS was used for pain assessment in almost all of the studies reviewed. This instrument has frequently been used to evaluate the effect of exercises on patients with OA of the knee. In the present study, the participants were asked about pain experienced during the week before entering the study, and initial mean VAS scores for pain were higher than those reported in previous studies. As expected, there was a significant decrease in pain in both groups, but hydrotherapy was not superior to land-based exercises. At the end of the study, there were reductions in VAS scores in both groups (89% and 45% reductions in the water-based and land-based exercise groups, respectively). This decrease in pain was statistically significant and clinically relevant, as a reduction of >17.5 mm in the VAS for pain has been recommended as the minimum clinically relevant change in therapeutic trials involving OA of the knee.[26]

The reduction in pain found in both groups is a very important benefit for such patients. Although we believe that this improvement occurred due to the strengthening of the leg muscles, we cannot affirm this due to the fact that we did not directly assess the strength of these muscles, as our primary objective was to assess improvement regarding pain and quality of life. We had expected pain to decrease more in the water-based exercise group than in the land-based exercise group. However, reductions in pain were found in both groups, thereby failing to demonstrate a greater benefit in the water-based exercise group and showing that water-based exercise is a real option for patients with OA of the knee.

At the end of our protocol, there was a significant and equal improvement as measured by the WOMAC and the Lequesne Index. This improvement was seen by the ninth week in both groups. Interestingly, only participants in the water-based exercise group continued to show improvement in these indexes up to the end of the study. Hurley and Scott[27] evaluated the effectiveness of a land-based rehabilitation regimen for patients with OA of the knee (2 exercise sessions per week for 5 weeks) and reported initial mean Lequesne Index scores similar to ours, whereas the final scores were higher than ours. This difference probably reflected the longer duration of our protocol (18 weeks versus 5 weeks in the study by Hurley and Scott) as well as the fact that Hurley and Scott used a protocol designed solely to strengthen the quadriceps femoris muscles, whereas our protocol was designed to strengthen all of the major muscles of the lower limb and also included gait training.

The participants were asked about their pain before and after the 50FWT, which at T18 was significantly lower, suggesting that hydrotherapy reduces pain associated with OA of the knee.[3,4] We believe that assessing pain at the time of evaluation may be a better representation of the pain experienced during daily activities than measuring pain experienced during the previous week. The assessment of current pain by a VAS at rest before the walk test also has been used by other authors.[28] We do not have a good explanation for the difference in pain between groups found before and after the 50FWT, and we consider the possibility that this reduction in pain may be a spurious finding.

People with OA of the knee generally have reduced gait speed due to pain.[29,30] The effects of exercise on gait as well as the use of walk tests to assess performance and therapeutic response have been evaluated in a systematic review.[7] Eight studies evaluating gait using 5 different gait tests reported either a small effect or a significant improvement in gait after exercise.[7] In the present study, the 50FWT was divided into walking time at comfortable and fast paces. A comfortable pace is normally used in daily activities, whereas a fast pace is more suitable for exercises such as aerobic activities. A significant improvement in walking time at comfortable and fast paces was observed in both groups during the study. We believe that this improvement may be explained by the reduction in pain and by potential improvements in strength and control of movement, which were not tested during this study.

The EULAR recommendations[5] reported 65 studies using the number of NSAIDs as a good quality measure for the assessment of pain in therapeutic trials. In a review by Petrella,[7] monitoring medication use also was found to be a good outcome measure for assessing pain. In our study, the use of sodium diclofenac to relieve pain decreased significantly in both groups by the third month of the study, and a further reduction was seen in the fourth month in the water-based exercise group. Overall, a 50% reduction in sodium diclofenac use was observed by the end of the study. It is important to emphasize that the reduction in the use of NSAIDs in this population is of extreme importance due to the risk of gastrointestinal and renal complications associated with the constant use of these medications for pain relief in the elderly population.[5] In contrast to our findings, Van Baar et al[31] observed no significant effect of exercise therapy on the use of NSAIDs in subjects with OA of the hip and knee (reductions of 35% and 23% in the exercise and control groups, respectively, at the end of the study). However, these authors used a weekly medication count compared with our monthly count and reported a higher mean use of NSAIDs than we observed in our study.

More participants concluded the water-based exercise program (96%) than the land-based exercise program (81%), indicating greater adherence to the treatment protocol in the former group. A recent study[32] compared the adherence of subjects undergoing hydrotherapy with that of a

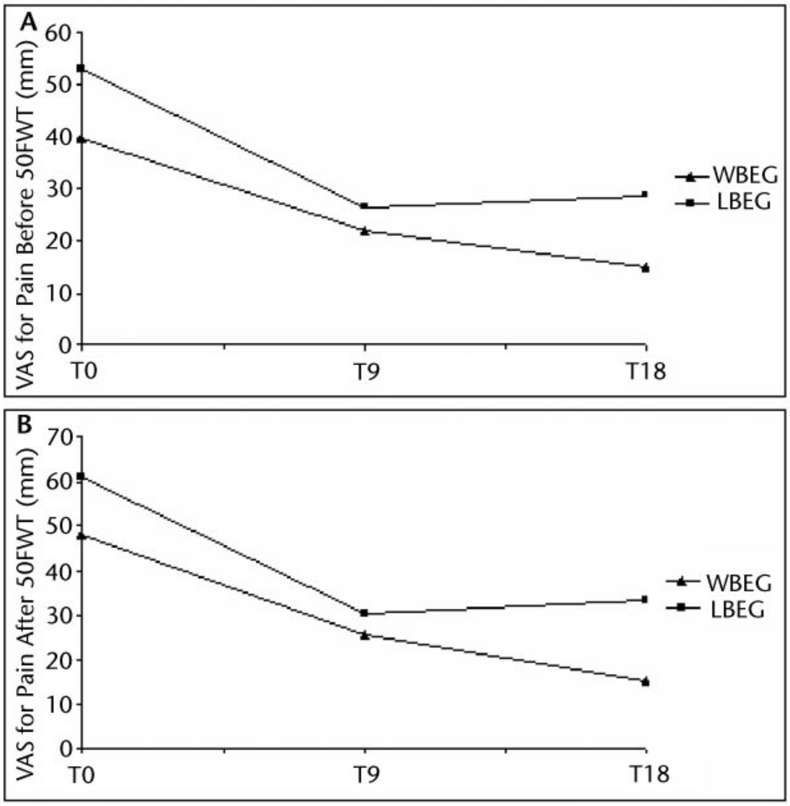

Figure.
Mean visual analog scale (VAS) for pain before (A) and after (B) the 50-foot (15.24-m) walk test (50FWT) in participants with osteoarthritis of the knee at 0 weeks (T0), 9 weeks (T9), and 18 weeks (T18) after intervention. LBEG=land-based exercise group, WBEG=water-based exercise group.

Table 5.
Comfortable and Fast Paces in the 50-foot (15.24-m) Walk Test (50FWT) and Monthly Use of Sodium Diclofenac in Participants With Osteoarthritis of the Knee at 0 Weeks (T0), 9 Weeks (T9), and 18 Weeks (T18) After Intervention

	Water-Based Exercise Group (n=32)	Land-Based Exercise Group (n=32)	*P* (Intergroup)
	Mean±SD (95% CI[a])	Mean±SD (95% CI)	
50FWT, comfortable pace (s)			
T0	12.94±15.12 (7.70–18.17)	13.19±15.57 (7.79–18.58)	
T9	11.64±13.14 (7.09–16.19)	11.81±13.46 (7.15–16.47)	.52
T18	10.72±12.22 (6.49–14.95)	11.11±12.75 (6.7–15.52)	
P (intragroup)	<.001[b]	<.001[b]	
50FWT, fast pace (s)			
T0	8.71±10.33 (5.14–12.28)	8.58±10.34 (5.02–12.14)	
T9	7.87±9.27 (4.66–11.08)	7.93±9.45 (4.66–11.20)	.69
T18	7.36±8.66 (4.36–10.36)	7.81±9.22 (4.62–11.00)	
P (intragroup)	<.001[b]	<.001[b]	
Sodium diclofenac 50 mg (no. of tablets)			
First month	31.63±19.79 (24.78–38.48)	31.1±19.78 (24.26–37.94)	.73
Second month	26.90±19.30 (20.22–33.58)	29.62±23.81 (21.38–37.86)	
Third month	17.10±19.52 (10.34–23.86)	20.37±21.91 (12.79–27.95)	
Fourth month	14.33±17.82 (8.16–20.50)	15.37±18.18 (9.08–21.66)	
P (intragroup)	<.001[b]	<.001[b]	

[a] CI=confidence interval.
[b] *P* value statistically significant.

control group (patients on a waiting list), and the authors concluded that patient adherence is fundamental to improving well-being, physical function, and quality of life. We believe that the adherence of our participants to treatment was high due to difficulties regarding access to such treatments in the public health system. They did not want to miss the opportunity to participate in the program. This was especially true for the participants who received hydrotherapy, which is even more difficult to come across in the public health system than land-based exercises.

The present study has some limitations, including the lack of a control group (without exercise) to compare with the 2 exercise treatment groups. However, because there is considerable evidence that land-based exercises are effective in patients with OA of the knee,[7,9,10] we decided to compare hydrotherapy with the gold standard of exercise intervention. Although the lack of a control group meant that we were unable to determine whether the improvements in both groups resulted from exercise or other factors, such as the duration of therapy or the degree of participant attention or motivation, we nevertheless believe that most of the improvement seen was attributable to the interventions used, as OA is a degenerative disease and would be expected to cause a progressive worsening of the participants' conditions.

The 2 physical therapists responsible for instruction in the exercise program were aware of the purpose of the study and tried to be impartial with both groups. We believe it is unlikely that their knowledge introduced any relevant bias. Moreover, the therapists were not involved with testing.

Foley et al[16] compared the effectiveness of hydrotherapy in patients with OA of the knee and hip with land-based exercises and an unexercised (control) group. There were many differences between our study and Foley and colleagues' study. Our program was longer than theirs (18 weeks versus 6 weeks), as were our sessions (50 minutes versus 30 minutes), and our participants were younger (mean age=59 years versus 70 years). The outcomes measured also were different between the studies. Foley et al assessed quadriceps femoris muscle strength, gait speed (6-minute walk test), and function and pain (WOMAC). The subjects in the study by Foley and colleagues were patients with OA of the knee and hip, which could have introduced significant bias in their analysis. Although their findings for pain and function were similar to ours, improvements were found over time in both studies, with no significant differences between groups.

Our results indicate that water-based and land-based exercises reduced pain and improved function in patients with OA of the knee and that water-based exercise was superior to land-based exercise for relieving pain before and after walking. These findings indicate that hydrotherapy is a suitable and effective exercise for patients with OA of the knee and should be included in the therapeutic approaches recommended for the management of such patients. Further research should investigate additional aspects of hydrotherapy, such as the long-term effects of this form of exercise and its ability to improve strength in patients with OA of the knee.

Ms Silva, Ms Jones, and Dr Natour provided writing. Ms Silva, Ms Pessanha, and Ms Myamoto provided data collection. Ms Silva, Ms Jones, and Dr Natour provided data analysis. Dr Valim, Ms Oliveira, and Dr Natour provided project management.

The study protocol was approved by the ethics committee at Universidade Federal de São Paulo/Escola Paulista de Medicina.

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