



# Aquatic Therapy Versus Combined Aquatic and Land-Based Therapy in the Treatment of Chronic Lateral Ankle Sprain:

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## Abstract:

**Purpose:** To compare the impact of the combined program containing land-based exercises and hydrotherapy to land-based exercises alone in patients with chronic lateral ankle sprain.

**Methods:** After being illegible for the study, forty patients assigned randomly into two equal groups, (group A) represented the hydrotherapy group; (group B) administered the combined hydrotherapy and land-based program with a frequency of two sessions weekly for one month.

**Results:** Findings revealed that patients in both the hydrotherapy group and the combined group had improved in pain, ankle functional ability, ROM, and satisfaction where there were no significant difference between groups ( $p > 0.05$ ). Also, there was no significant difference in satisfaction between both groups post-treatment.

**Conclusion:** Both the implemented combined water and land exercise, and land-based exercise programs could be recommended for rehabilitation to improve the precision of active ankle repositioning of individuals with residual symptoms of chronic ankle instability.

**Key words:** Chronic lateral ankle sprain, Land-based exercises, Aquatic physiotherapy, Satisfaction.

## 1.Introduction

Ankle injuries afflict both non athletics and athletics (1-3). Athletics are more involved (3,4) as they constitute about 45% of all athletic injuries (5). Generally, the most common musculoskeletal injury in sports is the chronic lateral ankle sprain, with 80% recurrence rate (6) leading to ankle instability. Contact sports such as landing, cutting, jumping, and running, are more involved (1). Heel strike or landing on a plantar flexed inverted foot together with excessive supination of the rear foot with lower leg lateral rotation possess stretching forces on the lateral ligament of the ankle complex precipitating lateral sprain (3,7,8).

The application of functional exercises in the late phase of recovery is beneficial in individuals having chronic ankle sprain where land-based exercises enhance neuromuscular function (9-11). Activities as jumping, running, landing, and hopping induce the pivoting action of the ankle. This requires good dynamic stability to prevent ankle injury and postural sway (12). Thus, land-based exercise is of utmost importance for patients suffering from chronic lateral sprain through providing proper ankle stability and muscle re-education. Striking the ground with high pressure imposes more loading than obtained in water as in most sports concerning jumping and cutting activities. Consequently, land-based exercises augment the structures around joints than water-based exercises. on the land (8).

Hydrotherapy is also crucial in treating chronic cases in athletes (10,13). It is necessary for rehabilitation of chronic ankle injuries (13,14). Warm water stimulates skin and underlying structures leading to a reduction in striated muscle tone, cutaneous vasodilatation, and a reduction in peripheral vascular resistance. Improving blood flow removes metabolites and toxins that aggravated pain by increasing aerobic metabolic activity causing analgesia. However, hydrotherapy advantages such as pain reduction (15) and psychological wellbeing may refine treatment strategy in the future (16,17). The warm hydro-massaging of water jets could calm patients under great pain by stimulating skin, nerves, and muscles. The balance between relaxation and practice could help a more confident vision to face the challenges of conducting activities, even post finishing hydrotherapy (18). The current study aims at comparing the co-intervention of land-based exercises and hydrotherapy, to land-based exercises alone in patients with chronic lateral sprain of the ankle.

## 2. Patients and Methods

### 2.1. Participants

A convenient sample of forty patients (30 males and 10 females) (24 Rt ankle, 16 Lt ankle) recruited from community outpatient hydrotherapy treatment clinics enrolled and assessed for their eligibility to participate in the study. All participants are football players and had one chronic lateral ankle sprain. They satisfied the following criteria at least perception of instability of the ankle joint, a repeated trauma, or ankle “giving away”; appropriate mechanical stability assured by an orthopedist through using anterior drawer test; and pain-free, full weight bearing, and level gait. The average time since the last episode of instability and injury was 3 months. Exclusion criteria involved fracture or a previous lower extremity surgery, swelling, or any systemic disease affecting the sensory input, medical history of hemophilia, metastatic disease; neuropathy of the lower extremity; an active infection (or taking medication for an infection), psychiatric disorder, pregnancy, cardiovascular disease (19). All subjects read and signed an informed consent form approved by the Beni-Suef University. A pilot study conducted on five male patients with chronic lateral sprain of the ankle aged from 18–35 years to estimate the inter-rater reliability for measuring outcomes. All individuals no evidence of previous trauma to their legs. Only patients with gradual cessation of the offending activity are involved. It was a prospective, randomized, single-blind, pre–post-test-controlled trial. Ethical approval obtained at Beni-Suef University. The study followed the Guidelines of

Declaration of Helsinki on the conduct of human research 1975.

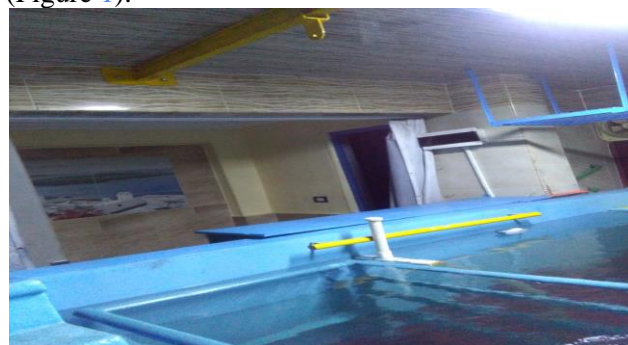
#### 2.1.1. Selection criteria:

Each patient signed a consent form after explaining the scope, objectives, and value of this endeavor. Patients randomly assigned into hydrotherapy alone or hydrotherapy and land-based treatment groups.

### 2.2. Instrumentation

#### 2.2.1. Therapeutic equipment:

The supporting ground withstood the weight of the aquatic therapy instrument filled with water and necessary equipment (3.5m length x 2m width x 1.7m depth and 15mm thickness born on iron framework) (Figure 1).



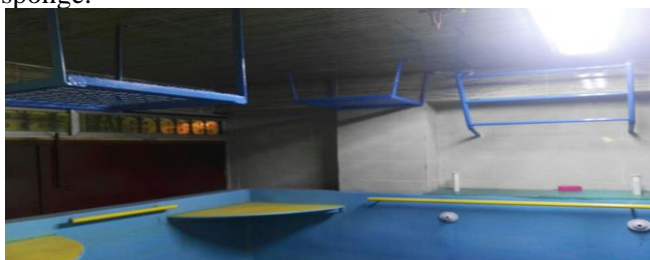
**Fig. 1: The domestic Aquatic therapy device.**

The instrument involved three water inlets, one skimmer, and built-in stopcocks fitting for water filling (up to 1.5 m) and draining. When water exceeded a specific level, sensors automatically stopped water filling. The operating system involved a pump of 1.5 Horse (Figure: 2) for the automaticity of water filling and draining. The device contained different accessories for ambulation exercises, and hydromassage. The presence of a belt anchored to a pulley in the ceiling facilitated ambulation in an upright position either in between parallel bars or on a sub-aquatic treadmill. Both shape and size of the pool considered no projections with walkway width 2.5m, adequate emergency access, and drain height of 4 inches. It had the following characteristics: anti-slip flooring, in-pool equipment, out-pool equipment, pump, filtration, heater, test kit, lighting, and control panel (20,21).



**Fig. 2: Pump & inlet and outlet plumbing connections**

Device accessories (Figure 3): handrails, parallel bars, sub aquatic perforated balance boards, fiberglass seat, in-pool and out-pool stairs, plastic mesh, swimming boards, inclined sidewall bar to decrease shoulder tension during the hanging, and conformable sponge.



**Fig. 3: Accessories: Mini wall bar, suspension, seats, and good lighting.**

#### 2.2.2. Instrument dynamics:

The filtration plant size was calculated using bathing load and pool volume. Magnetic water ensured effective salt-free water. well-maintained filtering media and a short turnover period led to suspended solids removal. Pump operated under flooded suction conditions and situated close to the balance tank and extraction points. It had a reasonable distance from the balance tank. The increment of the size of suction pipe accelerates the process of pumping. Turnover period of circulating water, bathing load together with the operating temperature 33.5 - 34°C and room temperature at 32°C assured a good performance (21). Air under pressure ensured sub-aquatic cleaning provided by a domestic vacuum cleaner or any other source of compressed air.

#### 2.2.3. Pre requisites of commencing a hydrotherapy session:

Excluding the contraindications of immersion, infectious conditions and active skin conditions; taking past and current medical history; ability to communicate, avoid risks of falls, assessing the independence level, occupation therapy assessment, strategy to reduce the fall risk: drying the floor at accepted defined intervals, showering pre and post executing the session, changing shower and toilet

facilities, defining weight-bearing status, describing gait aids used, steps or hoist; environmental management: wheelchair free zones, use footwear for patients lack balance, and finally, orientation (21).

#### 2.2.4. Security measures:

Taking fall history, assistance level for transfer, walk ways and wide entry, emergency procedures (21,22), towels in case of defibrillation, appropriate foot wear for stuff (22), equipment to remove patients from the pool, written documents regarding safety, infection control ,use handrail during entering and exiting, re-hydrate after aquatic therapy

#### 2.2.5. Guarding against water contamination:

Provision of shower and facilities, considering nappy aged children, checking for fecal materials, warning against excretions, hair, skin particles, cryptosporidium especially, in children which might cause diarrhea. Many disinfectants were effective such as chlorine, Bromine presented in chlorine tablets or calcium hypochlorite (oxidizes wastes, disinfectant). Water balance kept at 7 (if decreased hydrochloric acid with concentration 100ml/10,000L, if increased sodium bicarbonate used for treatment) (23).

#### 2.2.6. Reliability of the instrument:

The inter-reliability in the study was high for the ROM (24). Sample size calculation based on previous studies.

#### 2.2.7. Measurement equipment and tools:

The research outcomes measured before commencing and post finishing the treatment program.

##### 2.2.7.1. Visual Analogue Scale (VAS):

The primary outcome measure was pain. The 10-point visual analogue rating scale used to assess it, with zero refers to no pain and 10 the worst pain. The pain intensity was measured using VAS. This is a 10 cm calibrated line with zero representing no pain and 10 representing worst pain (25).

##### 2.2.7.2. The universal goniometer:

It used to measure ankle dorsiflexion, inversion, and eversion movements.

### 2.2.7.3. Likart scale

It was suitable to measure satisfaction after treatment. It ranged from zero to 10 points (26).

## 2.3. Procedures of the study

### 2.3.1. Therapeutic Procedures:

Participants were randomly assigned into; two groups (group A) the study group received hydrotherapy; (lateral step ups, squats, wobble (Figure 4) (Figure 5) (27). and the control group (group B) received hydrotherapy and land-based exercises (Isometric then, active assisted then free, the resisted, pain-free active ROM in all planes, towel scrunch, biking, open chain strengthening of hip musculature, proprioceptive training) (24,28) for 8 sessions over one week period healing. Each session involved 10 minutes warm-up, 20 exercises, then 10 minutes cool-down (29). Physiotherapy program for both groups included (45 minutes). Exercise programs designed individually based on patient examination and clinical findings as blinded subjects assigned to whether they received the hydrotherapy alone or the combined intervention.



Fig 4: Example of squat exercise.

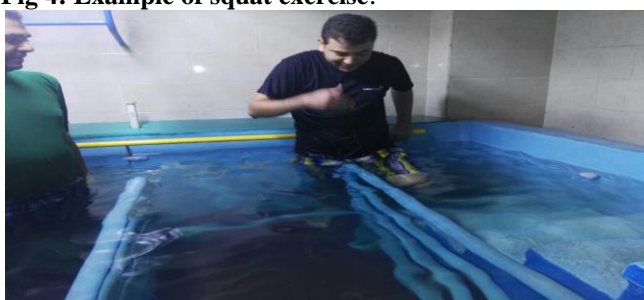


Fig 5: (a) Lateral step up &



Fig 5: (b) supporting on one leg exercises.

## Sample size and data analysis

To avoid a type II error, a preliminary power analysis [power (1- $\alpha$  error P) = 0.85,  $\alpha$  = 0.05, effect size = 0.87, with a two-tailed for a comparison of 2 independent groups] determined a sample size of 40 for each group. This effect size was calculated according after a pilot study of 10 individuals considering the pain level as a primary outcome. Conducting t-test for comparison of subject characteristics between both groups. Then, Chi-squared test for comparison of sex distribution between groups. Normal distribution of data checked using the Shapiro-Wilk test for all variables. Levene's test for homogeneity of variances conducted to test the homogeneity between groups. Mixed MANOVA performed to compare effects of treatment on VAS, functional scale, inversion and eversion ROM between the group A and B as between group comparison and between pre and post treatment in each group as within group comparison. Partial squared eta considered as the effect size. Post-hoc tests using the Bonferroni correction which carried out for subsequent multiple comparison. t- test conducted for comparison of satisfaction between groups post treatment. The level of significance for all statistical tests was set at  $p < 0.05$ . All statistical analysis executed through the statistical package for social studies (SPSS) version 19 for windows (IBM SPSS, Chicago, IL, USA).

## 3. Results

### 3.1. Subject characteristics:

Table (1) showed the mean  $\pm$  SD age of group A and B. There was no significant difference between both groups in the mean age ( $p = 0.44$ ). Also, there was no significant difference in sex distribution between groups ( $p = 0.46$ ).

Table 1: Comparison of subject characteristics between group A and B:

	$\bar{x} \pm SD$	MD	t- value	p-value	
	Group A	Group B			
Age (years)	23.4 $\pm$ 3.64	24.22 $\pm$ 2.81	-0.82	-0.77	0.44
Males/females	14/6	16/4		( $\chi^2 = 0.53$ )	0.46

$\bar{x}$ , Mean; SD, Standard deviation; MD, Mean difference;  $\chi^2$ , Chi squared value; p value, Probability value.

### 3.2. Effect of treatment on VAS, functional scale, inversion and eversion ROM:

Mixed MANOVA revealed that there was no significant interaction of treatment and time (Wilks' Lambda = 0.8;  $F(4,35) = 2.14$ ,  $p = 0.09$ ,  $\eta^2 = 0.57$ ).

There was a significant main effect of time (Wilks' Lambda = 0.05;  $F(4,35) = 145.65$ ,  $p = 0.0001$ ,  $\eta^2 = 1$ ). There was no significant main effect of treatment (Wilks' Lambda = 0.82;  $F(4,35) = 1.81$ ,  $p = 0.14$ ,  $\eta^2 = 0.49$ ). Table 2 showed descriptive statistics of VAS, functional scale, inversion and eversion ROM as well as the significant level of comparison between groups and the significant level of comparison between pre and post treatment in each group.

There was no significant difference between the group A and B in all variables pre-treatment ( $p > 0.05$ ). Also, there was no significant difference in VAS, functional scale, inversion and eversion ROM between group A and B post treatment ( $p > 0.05$ ).

**Table 2. VAS, functional scale, inversion and eversion ROM pre and post treatment in group A and B:**

	GA	GB	P
Pre-VAS	3.15 ± 1.06	2.74 ± 1.09	0.23
Post-VAS	1.23 ± 0.72	1.38 ± 0.94	0.59
P	0.0001*	0.0001*	
Pre-FS	68.2 ± 4.67	68.55 ± 5.21	0.82
Post-FS	77.05 ± 3.61	76.8 ± 3.45	0.82
P	0.0001*	0.0001*	
Pre-INR	24.45 ± 2.76	24.05 ± 3.26	0.67
Post-INR	29.75 ± 2.55	28.8 ± 3.33	0.31
P	0.0001*	0.0001*	
Pre-EVR	22.95 ± 2.21	23.15 ± 2.05	0.76
Post-EVR	25.85 ± 1.22	26.1 ± 0.91	0.46
P	0.0001*	0.0001*	

FS, functional scale; INR, inversion rang of motion; EVR, eversion rang of motion;  $\bar{x}$ , mean; SD, standard deviation; p-value, level of significance; \* Significant Between group comparison

### 3.3. Within group comparison:

There was a significant increase in the functional scale, inversion and eversion ROM post treatment compared with that pre treatment in both groups ( $p = 0.0001$ ). Also, both groups showed significant decrease in VAS post treatment compared with that pre treatment ( $p = 0.0001$ ).

### 3.4. Effect of treatment on satisfaction:

There was no significant difference in satisfaction between group A and B post-treatment ( $p = 0.11$ ). (table 3).

**Table (3): Comparison of satisfaction between group A and B.**

	Group A $\bar{x} \pm SD$	Group B $\bar{x} \pm SD$	MD	t- value	p- value
Satisfaction	9.35 ± 0.74	8.95 ± 0.82	0.4	1.6	0.11

$\bar{x}$ , Standard deviation; MD, Mean difference; p value, Probability value.

## 4. Discussion

The present study investigated the comparison of four weeks water and land-based exercise on improving ankle function and ankle ROM of football players with chronic lateral ankle sprain within the past six months. Results denoted no significant difference between both the aquatic and the combined programs in all variables pre-treatment ( $p > 0.05$ ). Also, there was no significant difference in VAS, functional scale, inversion and eversion ROM between group A and B post treatment ( $p > 0.05$ ). There was no significant difference in satisfaction between group A and B post-treatment ( $p = 0.11$ ).

Co-intervention of land-based exercises and hydrotherapy made it easy to interpret clinical effectiveness. On the other hand, comparing hydrotherapy alone to land-based exercises might make it difficult to interpret results to show what part of therapy was causing the effect seen which negatively affects clinical practice (30-32). The direction of forces in buoyancy opposes that of gravity, and hence the body feels lighter than on dry land (14). This study revealed no significant differences in ROM between the aquatic and combined groups which agreed with findings of Rahman et al. (31). Hydrotherapy had advantages compared with land-based because of exercising and warming (33). A combined program might be beneficial to athletics through helping more joint loading, accelerating rehabilitation and earlier return to previous activities (34).

The study results revealed that participants in both the hydrotherapy group and the land-based therapy group had improved ankle functional ability. This improvement occurred within group immediately after participating in the treatment program, whereas no differences were detected between groups ( $p > 0.05$ ). De Noronha et al. referred the lack of significant difference between programs to the minimal proprioceptive deficits in athletics with chronic lateral sprain of the ankle (12). Alternatively, these deficits may be were pronounced, but participants may use a compensatory strategy by using sensory input from other joints and structures. Furthermore, buoyancy and

non-weight bearing provide minimum dynamic postural stability which affect speed and direction of movements during exercises. Hence, the buoyancy acting in the opposite direction to gravity, it gives muscles, tendons, joints sense of being lighter (3,35,36). Moreover, water viscosity, resistance, ceases motion, response, and reaction time (37). Yelfani et al., (2015) postulated that females with chronic lateral ankle sprain had better pain, activity performance, and stability in both land and aquatic groups (35).

Although assuming the upright position during running in water, resembles walking, non-weight bearing exercise in warm water relieves both edema and pain in the hydrotherapy group. In the current study, there was evidence that aquatic exercise was effective in alleviating pain where there was no significant difference between the aquatic and combined programs. Waller, et al. speculated that (27) aquatic exercises could be effective in minimizing pain for adults (38). Furthermore, some studies found that hydrotherapy may reduce pain in individuals with a musculoskeletal injury when compared with no therapy, but not when compared with ground exercises.

## 5. Limitations of the study

Although exercising in warm water might be more comfortable for the athlete, the rise in temperature might cause fatigue or dehydration, and the strength and conditioning specialist should have awareness of the signs and symptoms associated with these conditions (39). However, the current study found no adverse reactions that contradicted the findings of Giaquinto et al.(40) who reported that an aquatic program had significantly fewer adverse events compared with a land-based program. It would be better to involve control group with home based exercises. Providing large sample size of athletics can be considered in future research. Finally, it would be better to classify the similar groups with corresponding sprain grade (1, 2 and 3) for future research to compare the effect of current interventions.

## 6. Conclusion

Aquatic therapy alone could reduce pain, improve function in subjects with chronic lateral ankle sprain. The implications of hydrotherapy alone may encourage therapists and patients to have the advantages aquatic field.

## Author's contributions

Both authors were fully involved in drafting this article and approved the submission of the final version for publication.

## Ethical approval

Ethical approval was obtained from the scientific research ethical committee in faculty of physical therapy, Beni-Suef University (No.: BSUPT07//07/2019)

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## Public trials registry

PACTR201705002185198

## Declaration of competing interest

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