



Postural stability changes after contrast immersion in ankle sprain: Randomized Controlled Trial

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Abstract:

Purpose: To investigate the effectiveness of contrast water immersion therapy on ankle posture stability in patients with a lateral ankle sprain

Methods: Thirty patients, grade I and II lateral ankle sprain, their age ranged between 18 to 35 years, they were randomly divided into two equal groups using coin flip. Interventions: Group (A) received a selected physical therapy program for ankle sprain patients. Group (B) Received contrast water immersion for 16 min in addition to the same selected physical therapy program received by group (A) for 4 weeks. For both groups, Biodex balance system was used to measure static balance before and after the treatment period.

Results: Analysis of data using ANOVA test show that there were a significant decrease in the overall stability index, Mediolateral stability index, and Anteroposterior stability index of the study group compared with that of the control group post-treatment

Conclusion: It's concluded that contrast water immersion for fifteen minutes in patients with lateral ankle sprain had a significant effect on static balance.

Keywords: Static balance, contrast water immersion, ankle sprain.

1 .Introduction

Lateral ankle sprain (LAS) is one of the commonest injuries in the lower limb. The incidence of residual symptoms and chronic ankle instability development after LAS have been reported with a percentage of 31:40 %. When LAS occurs, damage affects the structural integrity of the ligaments in addition to different mechanoreceptors in the joint ligaments, capsules, and tendons of the ankle complex. (1)

Proper rehabilitation in the earlier phases is vital to stop acute symptoms and signs as chronic sequelae. The most effective thermal modality in acute ankle sprains management has been well documented as cold therapy in the RICE protocol (rest-ice-compression-elevation). There are different effective thermal modalities during the management of the subacute phase, but which modality should be used is

not supported by literature besides the pre-chronic rehabilitation program. (2)

Researchers have a general assent that cryotherapy causes skin, subcutaneous, and muscle temperature decrease leading to blood vessels vasoconstriction and then inflammation and swelling relief through decreasing metabolite production. (3)

Conversely, heat application has been shown to increase tissue temperature, metabolite production, and muscle elasticity, to stimulate local blood flow and muscle spasm relief. (2, 3)

Contrast therapy involves the repetitive cold therapy application (cryotherapy) then heat in an alternating fashion (2).

The contrast hot-cold water technique is believed to enhance recovery by peripheral circulation improving through removing of metabolic wastes in

addition to stimulating the central nervous system (CNS). (4)

Balance is considered clinically as a motor skill, as balance defect may cause LAS recurrence and decreased function of the lower limb. (1)

Balance maintenance is essential in the prevention of injuries, and this ability relies on proprioceptive contribution from capsuloligamentous and musculotendinous mechanoreceptors in combination with vestibular and visual inputs to CNS. This information is utilized in feedback and feed-forward loops to give the proper neuromuscular reaction. Variations in any of this information would disturb the balance and increase injury risk. (5)

Balance is maintained by strategies at the hip, knee, and ankle and maybe disturbed when joint positions cannot be properly sensed or with uncoordinated corrective movements. (1)

Single-leg balance (SLB) assessment is a common clinical practice following acute lateral ankle sprain (ALAS) because poor SLB is considered a risk factor for recurrent injuries and chronic ankle instability (CAI). It is of clinical interest to investigate whether or not visual adaptation occurs immediately after injury, which has rehabilitation implications for acute patients, given that SLB deficits are also prevalent in ALAS patients and impairments appear to be more consistent during SLB with eyes closed. (6)

Contrast therapy was first used as primary management of injury while lately it has been used to improve recovery of the after-exercise period. (3) Finding the scientific evidence basis of contrast therapy effect needs more understanding of its physiological effect relying on purely physiological basis. (7)

While many effects have been shown (including edema, pain, and muscle stiffness relief, blood flow alteration through vasoconstriction, vasodilation, and inflammation reduction), the physiological basis of contrast therapy is not well understood. (8, 4, 9, 10, 3, 11)

The effect of contrast therapy in the pre-chronic stage of ankle sprain has no much literature, which make it difficult to realize the effect of contrast therapy directly on pain, range of motion (ROM), and postural stability. (2)

This study was performed to show the contrast water immersion therapy effect on posture stability in lateral ankle sprain patients.

2. Patients and Methods

The study was performed in the Physiotherapy and rehabilitation Department in El-Helmia Military Hospital for Orthopaedic Surgeries, Cairo, Egypt from January 2019 to February 2020. Before starting the study, the participants were received the study

information form, instructions and signed the consent form, the study was approved by the Cairo university ethical committee council (P.T.R.E.C/012/002130) on 4/11/ 2018.

Subjects:

The sample size is 30 patients in the 2 experimental groups (n=15 in each group). Sample size calculation is based on a power analysis done calculating the effect size from outcomes of a previous study. (5) Using Power and Precision V4 software. Results confirmed with G Power v3.1 software results. Power set to (0.8) and significance level to (0.05) results was 28 patients (14 per one group); addition of 4 patients to each group to avoid dropout of total patient number. (5)

Inclusion criteria:

Thirty patients were selected clinically diagnosed as subacute grade I and II lateral ankle sprain (2), after the fifth day of injury (12, 13), within average age ranged from 18:35 years, BMI 25-30 Kg/m² of both genders. All patients required to be able to walk 10 meters unassisted, Patients began rehabilitation training 5th:10th day post-injury including proprioceptive training (ground and balance training), lower limb strength exercises. (12, 13)

Exclusion criteria:

Patients were excluded if he/she has:

- Different sensory defects (such as previous nerve injuries, diabetes that lead to sensory defects in the ankle)
- Grade III ankle sprain which required surgical repair or cast immobilization, and other ankle injuries such as high ankle sprain (syndesmosis injuries), medial ligament injuries, and fractures.
- Severe Osteoporosis and Gross Musculoskeletal problems.
- Balance disturbance rather than ankle sprain as ear problems, labyrinthitis, stroke, or cerebellar problems.
- Visual disturbance.
- Vestibular defects.

Design of the study:

A single trained investigator evaluated all patients and collected all the data to eliminate the inter-investigator error.

Participants were randomly assigned by flipped coin method before assessment procedure into two groups each group included 15 participants:

Group A: received selected physical therapy program for ankle sprain patients (balance training and active ankle ROM) only, for 4 weeks.

Group B: received contrast water immersion in addition to the same selected physical therapy

program received by group (A), for the same period.

Measuring outcomes: Postural stability

- Anterior/ Posterior posture stability index.
- Medial/Lateral posture stability index.
- Overall posture stability index.

Procedures:

A) Evaluation procedures:

The Balance was assessed using the Biodex balance system, each participant completed a practice session for static testing immediately before balance measurement. Following familiarization, a ten-second test was performed. (14)

Testing was performed bilaterally bare feet with the

participants' hands beside their hips and with eyes open. Visual feedback regarding the center of gravity (COG) location or tilt from the BBS computer screen was provided.

Any trial in which the participants' hands moved away from hips was deleted and repeated. (14)

B) Treatment procedures:

Both groups had received a selected physical therapy program designed for ankle sprain for 3 sessions/week for 4 weeks (12 sessions). (15)

The Physical therapy exercise Program.

Table (1) Description of the training program. (15)

Level	Week1 (A)	Week 2 (B)	Week 3 (C)	Week 4 (D)
1	DLS with lumbar control 2×10 Toe raises 2×20 DL heel raises 2×20	DLS on BOSU 2×10	DL compressions on BOSU 2×20	Forward/backward hop on BOSU 2×20
2	DL skiing exercise on BOSU 2×10 (side to side squats) SL heel raises 2×10	DL box jumps onto Reebok step 2×15 (stabilize on landings)	SL step up on Reebok step 2×10 SL step down on Reebok step 2×10	SL lunges forward 2 ×10 SL lunges side to side 2×10
3	SLS 2×10	As in B2 above but Increase step height	As in C2 above but increase step height	SL hopping forwards 2×10 (stabilize on landings) SL hopping sideways 2×10 (stabilize on landings)
4	SLS 2×10 and hold in Squat position for 10 Sec. after 10 squats	DL bunny hop on BOSU 2×10 (stabilize on landings) DL lateral bunny hop on BOSU 2×10 (stabilize on landings)	SL step up on BOSU 2×10 SL step down on BOSU 2×10	SL hops on BOSU 2×10 (stabilize on landings) lateral SL hops on BOSU 2×10 (stabilize on landings)
5	SLS on BOSU 2×10	High knee lifts on BOSU 2×20	Lung from step on BOSU 2×10	As in D4 but increase distance Of jump on BOSU

SL, indicates single leg; DL, double leg; SLS, Single-leg squat; DLS, double-leg squat; BOSU, both side up balance trainer

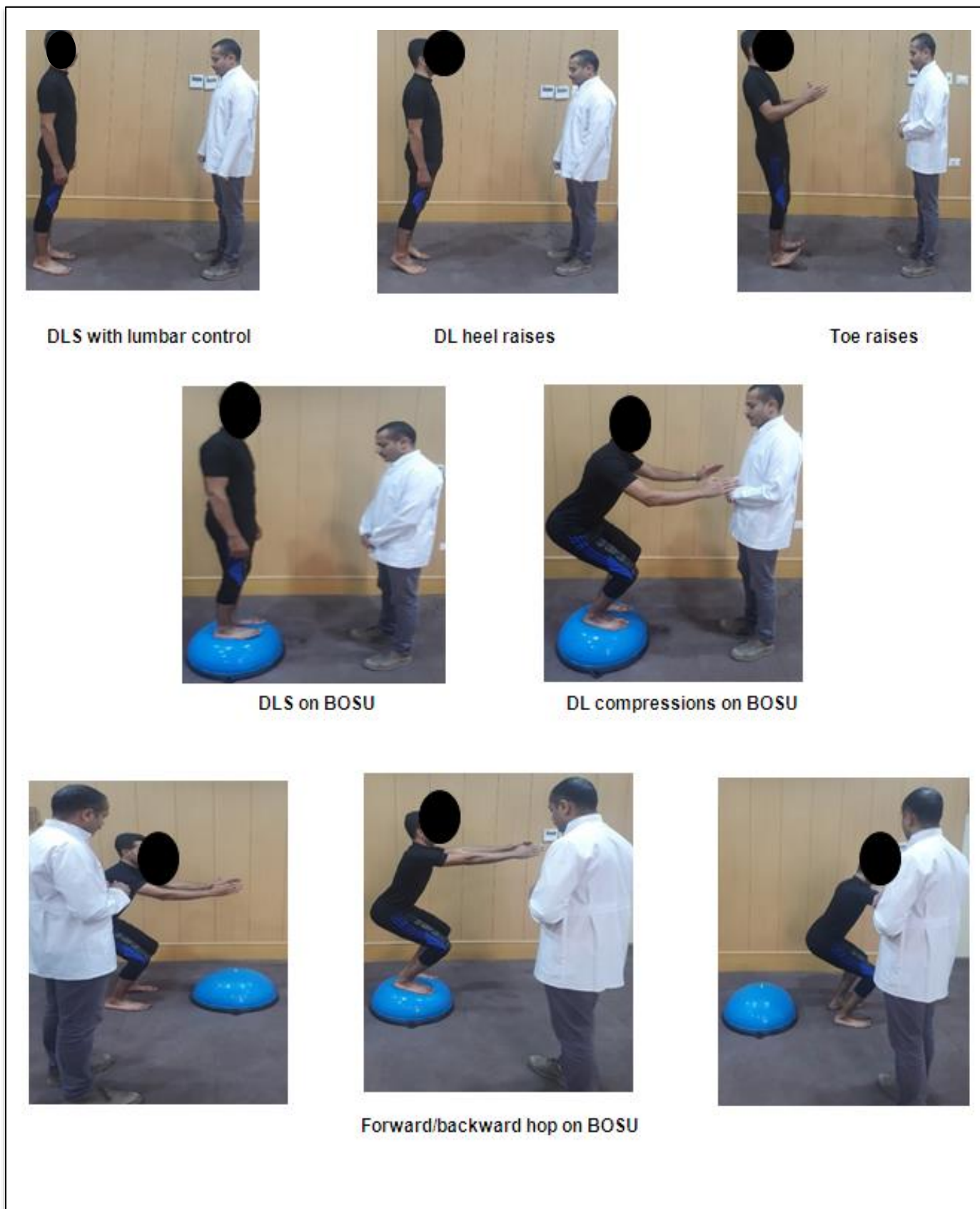


Fig (1): Level 1 Exercises.

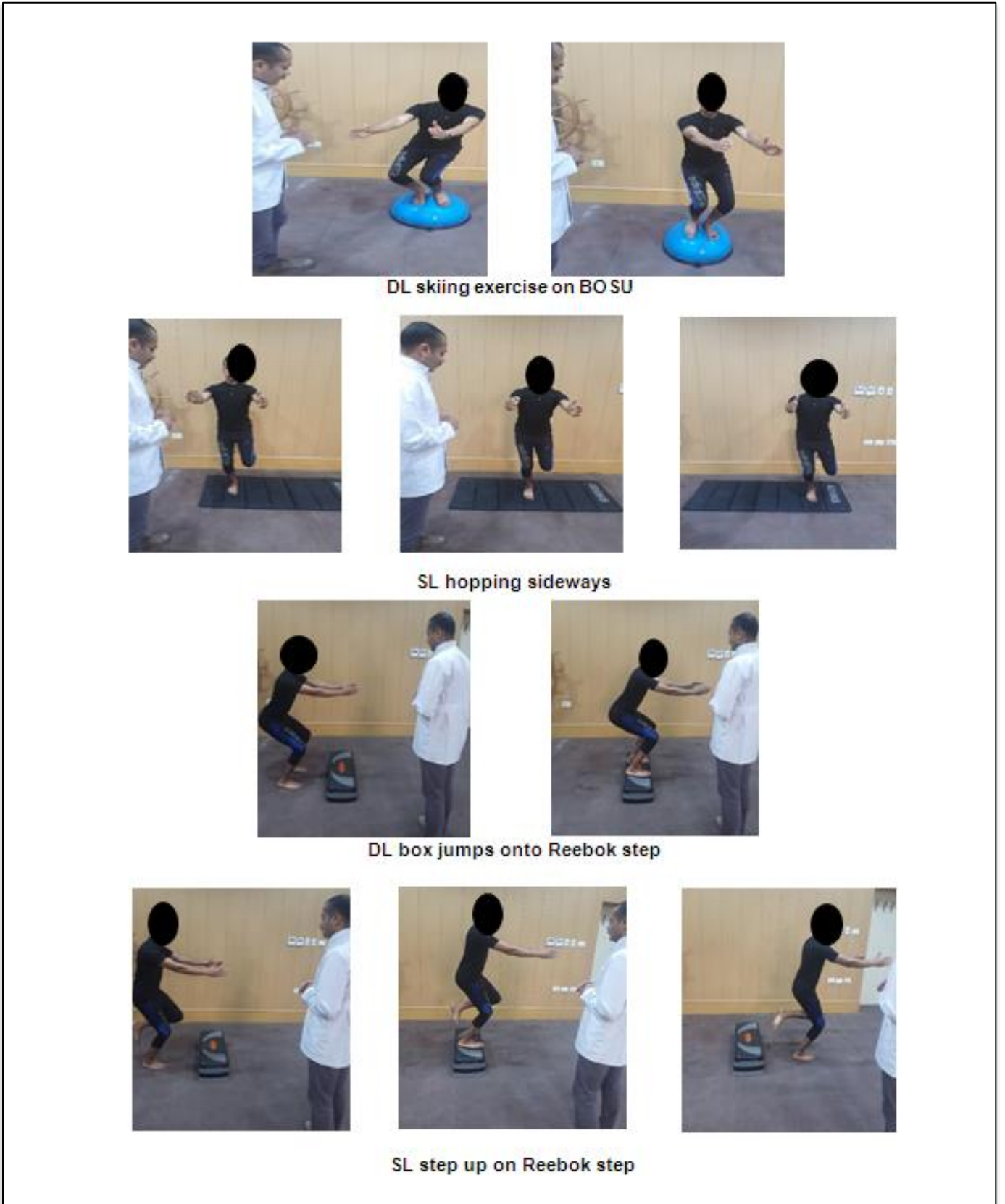


Fig (2): Level 2, 3 Exercises.

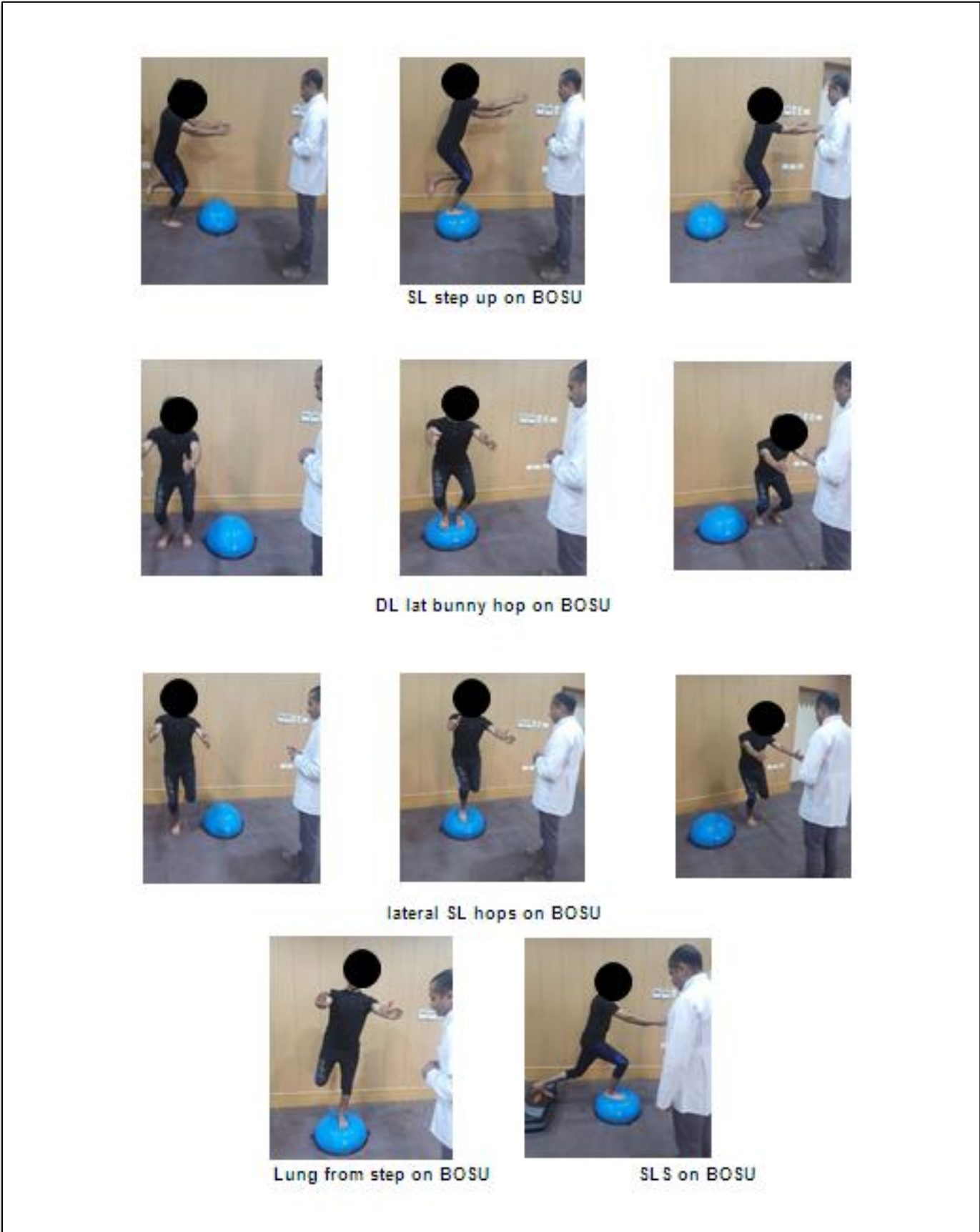


Fig (3): Level 4, 5 Exercises.

Contrast water immersion:

Only the experimental group had received a contrast water immersion program for 4 weeks as 3 sessions/week (12 sessions).

Before starting the experiment, subjects were sat and rest for 20 minutes at room temperature (25°C).

Two metal whirlpool (75 gallons, 132 length × 61 width × 46 depth) were used, the temperature of hot water was kept at a medium temperature of 40°C, verified by the laser thermometer, and then for cold water immersion, ice was added in the second whirlpool till the temperature of 5°C. The hot and cold water used for the contrast baths was maintained at a constant temperature of 40°C and 5°C by heating water or adding more ice respectively for the whole treatment period of 16 min (4 cycles).

The Subject sat with the angle of hip and knee close to 90° with the immersion of the lower limb below mid-Calf level. (11)

Subjects' foot were then submerged for 3 minutes in a hot bath. Then transferred immediately and submerged for 1 minute in the cold bath. Repeating this cycle 3 more times for a total of 4 cycles (16), starting with hot and ending with cold. (7)

3. Results:

- **Subject characteristics:** Table 2 showed the subject characteristics of both groups. There was no significant difference between both groups in the mean age and BMI ($p > 0.05$). Also, there was no significant difference in sex distribution between groups ($p > 0.5$).

Table 2. Participant characteristics.

	Study group	Control group	t-value	P-value
	$\bar{x} \pm SD$	$\bar{x} \pm SD$		
Age (years)	25.6 ± 5.55	26.06 ± 4.7	-0.24	0.8
BMI (kg/m ²)	26.67 ± 1.11	26.6 ± 2.28	0.11	0.9
Males/females	10/5	7/8	($\chi^2=1.22$)	0.26

\bar{x} , Mean; SD, Standard deviation; χ^2 , Chi-squared value; p-value, Level of significance

Effect of treatment on OVSI, MLSI, and APSI:

- Within-group comparison:

There was a significant decrease in OVSI, MLSI, and APSI post-treatment compared with that pre-treatment in the study and control groups ($p < 0.001$). The percent of the decrease in OVSI, MLSI, and APSI in the study group was 53.7, 52.12, and 51.57% respectively, while that in the control group

was 39.14, 44.75, and 36.38% for OVSI, MLSI, and APSI respectively. (Table 3, Figure 4).

- Between groups comparison:

There was no significant difference in OVSI, MLSI, and APSI between both groups pre-treatment ($p > 0.05$). Comparison between both groups post-treatment revealed a significant decrease in OVSI, MLSI, and APSI of the study group compared with that of the control group ($p < 0.01$). (Table 3, Figure 4).

Table 3. Mean OVSI, MLSI, and APSI pre and post-treatment of the study and control groups:

	Study group	Control group	MD	t-value	P-value
	$\bar{x} \pm SD$	$\bar{x} \pm SD$			
OVSI					
Pre-treatment	5.4 ± 1.29	5.16 ± 1.87	0.24	0.42	0.67
Post-treatment	2.5 ± 0.67	3.14 ± 0.71	-0.64	-2.55	0.01*
MD	2.9	2.02			
% of change	53.7	39.14			
t-value	9.55	5.86			
	$p = 0.001^*$	$p = 0.001^*$			
MLSI					
Pre-treatment	4.24 ± 1.13	4.67 ± 0.97	-0.43	-1.11	0.27
Post-treatment	2.03 ± 0.41	2.58 ± 0.53	-2.51	-3.18	0.004*
MD	2.21	2.09			
% of change	52.12	44.75			
t-value	10.38	10.12			
	$p = 0.001^*$	$p = 0.001^*$			
APSI					
Pre-treatment	3.8 ± 0.95	3.71 ± 0.85	0.09	0.27	0.78
Post-treatment	1.84 ± 0.63	2.36 ± 0.5	-0.52	7.06	0.01*
MD	1.96	1.35			
% of change	51.57	36.38			
t-value	7.1	8.71			
	$p = 0.001^*$	$p = 0.001^*$			
\bar{x} , mean; SD, standard deviation; MD, mean difference; p-value, probability value; *, significant					

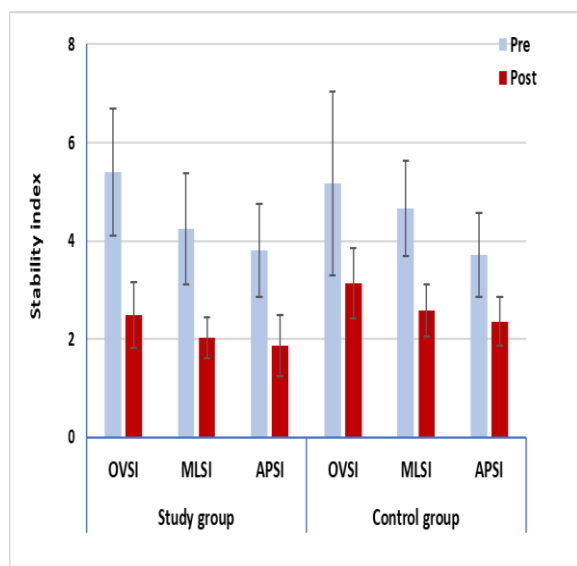


Figure (4): Mean OVSI, MLSI, and APSI pre and post-treatment of the study and control groups.

4. Discussion

This study was designed to show the effect of contrast water immersion therapy on ankle postural stability in patients with a lateral ankle sprain.

Our results show that there was a significant decrease in OVSI, MLSI, and APSI of the study group compared with that of the control group post-treatment, which means an improvement in all indices of stability.

Our findings supported researchers who reported that 30 subjects with ankle sprain were participated and randomly divided into two groups 15 each. Group A, received ice pack application, Group B, cold water immersion for 20 minutes for 10 days. Balance error scoring system was used to assess static balance, Star excursion balance test was used to assess dynamic balance before and after the interventions, then analyzed by using the student's 't' test. The static balance for both groups showed a decreasing number of errors in tandem stance and double limb stance after ice pack application, while there is no difference found in single-limb stance. Dynamic balance increased in ice pack application compared to ice water immersion. Better improvements in both dynamic and static balance after ten days application of ice packs than immersion in cold water athletes' sprained ankles. (17)

Our results on the same line with Sayomi et al., (2015) (18) who performed a Cross-sectional study for 30 male subjects by applying 5 °C cold water immersion for 15 minutes then balance assessment by a force platform with a protocol of 3 trials of 30 seconds with 10-sec rest in between, the average of

the 3 trials was used. Results showed that performing activities became safer after cryotherapy by postural balance improvement after cold water immersion.

It comes in agreement with Fullam et al. , (2015)(19) who tested 29 male college elite-level athletes using Star Excursion Balance Test on the anterior (ANT), posterolateral (PL), and posteromedial (PM) reach directions before and after a cryotherapy application for 15-minute on ankle joint. They found a decrease in reach-distance scores for all directions after cryotherapy comparing to pre- cryotherapy balance results. So Dynamic postural stability was decreased immediately after cryotherapy to the ankle joint. (19)

On the other hand, our results in contrary with Yomna et al., (2017) (5) who investigated 30 healthy subjects dividing into two groups: (1) A study group where the subject received the cryotherapy application for 15 minutes by using cooled gel pack to the dominant ankle joint then static balance testing and (2) A control group for only static balance testing by using a Biodex balance system. The result suggested that there was no effect after application of cold gel pack for 15 minutes on dominant ankle extremity on static balance.

5. Conclusion

Application of contrast water immersion therapy had a significant on postural stability in patients with a lateral ankle sprain

Conflict of Interests

The authors declare no conflict of interest.

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