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Rehabilitation of Acute and Chronic Ankle Sprain of Male Cricketers Through Aqua Exercise

Abstract

Ninety-seven amateur cricketers of age,15-35 years (Control Injured, n=48; Aqua Rehab Group n=49) with confirmed acute or chronic ankle sprain, selected from four different cities of the Punjab, Pakistan was evaluated through Star Excursion Balance Test (SEBT), Single Leg Balance test (SLB) and subject to a set of progressively increasing exercises in water known as Aqua exercises. Another group of same level cricketers (n=40) was managed parallel for comparisons. The Control Injured and Aqua Rehab Group was left with 40 subjects each because during the course of Aqua exercise eight and nine subjects left the study due to their personal reasons. Comparisons of pre and post exercise (Control Injured Group) values showed significant increase ($p<0.01$) in Lateral direction reach and Posterior Medial direction ($p<0.05$) while the rest of the six directions showed non-significant results. Aqua Rehab Group showed an overall improvement of 4% and 6.3% with an increase (cm) of 2.7 and 4.1 for the non-injured and injured leg respectively. However, the range of improvement in (%) for all eight directions (Anterior, Anterolateral, Lateral, Posterolateral, Posterior, Posteromedial, Medial, Anteromedial) lies between 11.6-14.2 and 11.3-14.1 for the non-injured and injured leg respectively. Similarly, the difference between pre and post exercise difference of two positions of non-injured leg and injured leg (closed and open eyes) in seconds were 2.8, 1.7 and 6.8, 6.6 respectively. However, the improvement (%) of two directions (closed and open eyes) of Aqua Rehab Group was 8.8 and 4.8 for non-injured and 39.9 and 25.8 for injured group respectively. It was evaluated through Single Leg Balance Test and analyzed by paired sample t-test found highly significant ($p<0.001$). The results indicated that aqua exercises improved isometric and isotonic muscular strength, proprioception and stability that ultimately helped to recover, regaining strength and reinstall proprioception. After completing the Aqua Rehab plan the subjects were followed for four months

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to check the recurrence that was found 8% and 5% for Control Injured Group and Aqua Rehab Group respectively.

Keywords: Ankle sprain, Acute, Chronic, Rehabilitation, Hydro exercises, Recurrence.

Introduction

An acute ankle sprain is defined as "A traumatic injury to the overstretching of the ligament of the ankle joint as a result of inversion and eversion or a combined plantar flexion and adduction of the foot" (www.phillobeukes.co.za). This commonly affects some initial deficits of function and disability (Lubbe *et al.* 2015,22; Doherty *et al*. 2017, 113). A chronic ankle sprain is defined as "An old injury that doesn't heal properly, leading to re-injury of weakened tissues (www.advancepodiatary.com)". Sometimes athletes with injury do not consider it a big deal and do not seek medical attention which may result in prolonged pain and recurrence of ankle sprain (Gribble *et al.* 2013,978; Doherty *et al.* 2016,995). In past, classic techniques have been in use to treat this injury and to check the risk factors, e.g, electronic stimulation, taping, cryotherapy, bracing, mobilization, strength training, proprioception and postural sway methods (Witjes *et al.* 2012,21).

The pre exercise and post exercise values have been evaluated through Star Excursion Balance Test (SEBT) and Single leg balance test (SLB). The purpose of the tests was to obtain baseline information. SEBT is a simple, efficient, accurate and dynamic assessment during which the subject has to maintain his center of gravity without losing balance and it can differentiate subjects with lower extremity injuries. Therefore, it might be used as a baseline indication of normalization of neuromuscular control after ankle sprain injury. The SLB was a static balance test executed as the subject standing on one leg near a wall (support) and time has been noted in seconds. Both the tests were discarded if the subject was unable to maintain his balance (Gribble and Hertal 2007, 236).

Aquatic therapy is a group of lower and upper body joint movements while the body was immersed in the water. These have been used therapeutically for patients with a variety of diagnoses, including rheumatic diseases. The majority of literature which describes contraindications, mechanisms and actions for developing hydro exercise plans for patients helped to stabilize moment, blood circulation, less impact on the joint and reduce pain in the joint (Templeton *et al.* 1996,376). Mattacola and Dwyer (2002,413) reported that exercises in water, reduce the force and according it results in lessor impact on muscles and joints as it supports the injury. They further added that exercises should be started with light resistance and progressed until functional exercises will be performed. They also presented some functional treatment protocols to manage ankle ligament injuries, which consisted of various modalities such as flexibility exercises, isometric strength training and isotonic strength, balance training and ankle joint proprioception. It concludes that exercises in water help to recover efficiently (Kavanagh 1999,19). To avoid re-injury or risk of spraining there must be a rehabilitation plan that strengthens the local muscles and is considered essential for regaining the full range of motion (functionality) by doing ankle strength

training. Training and rehabilitation concept had the space to improve the anterior portion of the muscles of the foot and thus enable to rejoin the previous playing condition (Hubbard and Denegar 2004,278). According to proponents, water was used because it is invigorating and causes superficial blood vessels to constrict, shunting the blood away from the surface to internal organs. The physical properties of water (relative density, buoyancy, hydrostatic pressure, fluid resistance, movement through water and moment of force) had been utilized to reduce the gravitational forces. Water causes superficial blood vessels to dilate, activating sweat glands and removing wastes from the body tissues, stimulates the touch receptors on the skin, increasing blood circulation and releasing tightness of muscles. The healing properties of hydrotherapy are based on its mechanical and thermal effects. Water helps to recover quickly through different water temperature (hot, cold) as the water relieves the body which impacted by gravity. The training was increased in every session through the progression principle, specificity, overloading and condition of the subjects as well (Kofotolis *et al.*, 2014,37). Physiotherapist and trainers used water therapy (hot and cold) technique to facilitate and rehabilitate weak muscle functionality.

Our present study was conducted on amateur cricketers with confirmed Acute and Chronic ankle sprain selected from four major cities of Punjab (Lahore, Faisalabad, Gujranwala, Sialkot) from December 2016 to December 2018. Aqua exercise plan (dorsiflexion, plantar flexion, inversion movement eversion movement and mobilization walking and jogging, standing on one leg with (open and closed eyes)) and evaluated through SEBT and SLB Test. Aqua exercise session utilized the principle of progression, overloading and specificity for eight weeks. The exercise session increased at least 10% in every weekly plan (Dubin *et al.* 2011,204). The intensity of the exercises was weekly increased till eight weeks from light to high along with two unloaded week (4^{th} and 8^{th}).

Hypothesis

The Study hypothesized that rehabilitation through the Aqua Rehab exercises in water) is an effective method and cut down the recurrence.

Methodology and Procedure

Ninety-seven male subjects were selected, their age was (15-35) years, having acute and chronic ankle sprain injury of duration 2 years (December 2016 to December 2018) passed through the Rest, Ice Compression and Elevation (R.I.C.E) protocol to get rid of initial pain (if needed). This study used a selective sampling technique. The data collected from 4 major cities (Lahore, Faisalabad, Gujranwala, Sialkot) of Punjab, having proper cricket facilities. The researcher endorsed the purpose of the study and signed their consent form. Age, weight and height measurements of the selected subjects were taken. The subjects were divided into the Control Injured group (n=48) and Aqua Rehab Group (n=49). The subjects were medically fit except ankle sprain. The Aqua Rehab exercise plan was executed in Punjab University female swimming pool and their respective clubs and private swimming pools. The data was normalized for the different heights of subjects, reach distances, the researcher calculated the normal values for the reach distances by dividing each direction by their respective height (Gribble and Hertal 2003,189) and normality was checked through the Shapiro-Wilk test. The test showed they were normally distributed. Probabilities of less than 0.05

were considered significant. SLB was considered to be a simple test. Forty Normal Control subjects were also taken for further comparison. Pre and post exercises were executed and evaluated through SEBT and SLB test for dynamic and static balance. The subject executed the hydro exercises plan on non-injured and injured leg. Before starting the test subject were given a verbal and visual demonstration and they performed six practice trials as recommended by Gribble and Hertal (2003). The test was evaluated by standing on the star grid on even and flat surface. The star grid was drawn by using a protractor, white tape and a measuring tape with eight lines marked out from the center at 45 degree angle and their names as according to the reach from the standing leg directions (Anterolateral, Anterior, Anteromedial, Medial, Posteromedial, Posterior, Posterolateral, and Lateral). The subject was asked to stand in the middle of the grid and touch the lines with his toe (non-injured and injured leg) in all eight directions. The maximum reach of each direction was measured in centimeter. The Single Leg Balance Test was executed as subject standing on single leg near a wall (support) and time has been noted in seconds, it was discarded if the subject was unable to balance his body and foot could not touch the ground and both the tests were repeated thrice, average of 3 values were taken in order to avoid any discrepancies (Gribble *et al.*, 2007). The grid is shown in Fig. 1

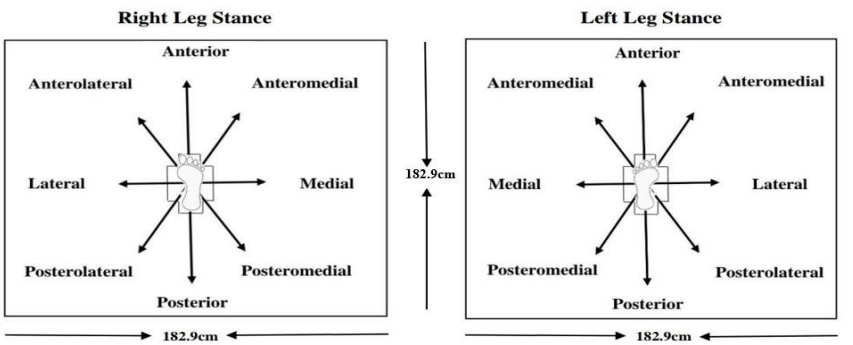


Fig.1 Showing 8 directions (Anterolateral, Anterior, Anteromedial, Medial, Posteromedial, Posterior, Posterolateral, and Lateral) of the Star Excursion Balance Test of Right/Left leg stance (After Gribble *et al.*, 2012,239).

The subject was standing on non-injured and injured leg on a hard surface near a support as much as he can in seconds with closed and open eyes. The time was noted in seconds and values had been observed for further comparison. The subject was given 3-5 minute rest to repeat the same process for the other leg. Eight subjects from the Control Group and nine subjects from the Aqua Rehab Group have left and did not available for the final post-testing. The cricketers enrolled in the rehab program started with 2-3 sessions/week were executed with duration of (25-30) minutes for 8 weeks. Principle of progression, overloading and specificity principles was utilized. The Fig. 2 showed the flow chart of the study

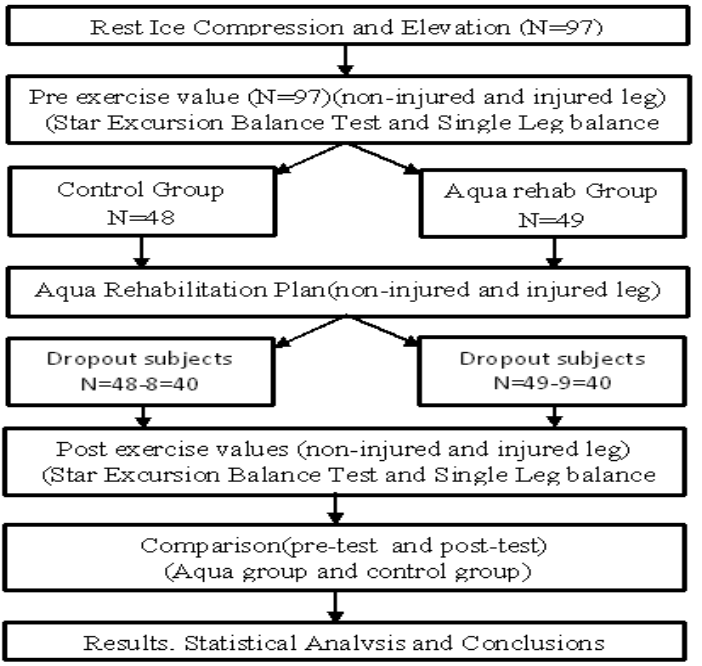


Fig. 2 Showing activities of Amateur Cricketers (N=97) with Acute and Chronic Ankle Sprain consisted of Normal Control (NC,40), Control Injured (CI,48), Aqua Rehab Group (A,49) for Rehabilitation exercise plans for 8 weeks of duration, Subjects were selected from four major cities of Punjab from December 2016 to December 2018.

The test was discarded if (a) Subject was unable to maintain his balance. (b) Foot displaced while performing the test; heels off and toes off of the floor. The exclusion criteria were that the cricketers were medically fit except ankle sprain. Isometric strength training, Isotonic strength training, proprioception and Sports specific training were executed in 24 sessions within the time frame of 8 weeks (3 days/ per week) as a rehab exercise plan and its duration was 30-45 minutes as the rehab program proceeded. Control group (CG) did not get any sort of the treatment and they were on medicine as prescribed by the physician.

Data Analysis

The data were expressed as Mean ± Standard deviation analyzed using SPSS (Statistical Package for Social Sciences) Ver.22 (SPSS Inc. Chicago, II, USA), SEBT and SLB test were analyzed using paired sample t-test (Steel and Torrie, 1980).

Aqua Rehab Group

Before starting the Aqua rehabilitation plan the subjects (N=49) were evaluated through Star Excursion Balance Test (SEBT) and Single Leg Balance Test (SLB) for non-injured and injured legs. These values were denoted as pre exercise. This

group executed hydro exercises for the duration of eight weeks. In this duration 9 subjects left the study due to their personal reasons, leaving behind 40 subjects.

Aqua rehab group (Individual improvement)

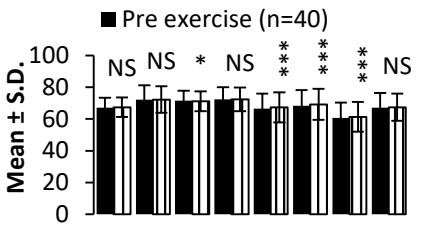
The difference between pre and post exercise evaluated through SEBT and SLB resulted of non-injured leg of the Aqua Rehab Group tested through Star Excursion Balance test indicated that there was an overall improvement (2.3 ± 0.3%) in all eight directions. Mean ± S.D. values for pre exercise (n=49) and post exercise (n=40), showed a change from 66.5 ± 5.6 to 69.2 ± 5.9 with a difference of 2.3 ± 0.3. A mean difference in pre and post exercise results of the SEBT (injured leg) with an improvement in all eight directions. Mean ± S.D. in subjects showed that their pre exercise (n=49) and post exercise (n=40) values changed from 64.7 ± 4.8 to 68.8 ± 4.4 with a difference of 5.1 ± 1.3 thereby showing percentage increases of 8.1 ± 2.1. The percentage change between pre and post exercise results of non-injured leg through Single Leg Balance Test indicated that there was an improvement in both positions. Mean ± S.D. values of subjects with non-injured leg, changed from 47.3 ± 3.4 to 50.4 ± 3.7 with a difference of 3.1 ± 1.0 thereby showing percentage of 2.5 ± 0.8. The difference between pre exercise (n=49) and post exercise (n=40) values for SLB Test of injured leg, showed an improvement (2.5 ± 1.7%) while balancing with close eyes and open eyes. These values changed from 49.1 ± 5.5 to 51.8 ± 5.2 with a difference of 3.3 ± 2.2.

Aqua Rehab Group (Star Excursion Balance Test)

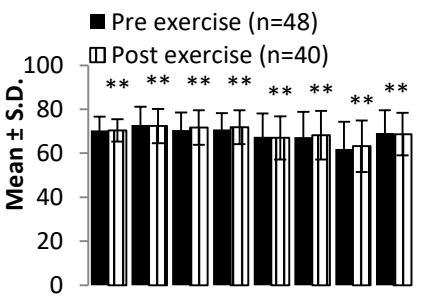
The subjects in Normal Control (CI=40) did not do any special exercises, but they were performing their normal activities. However, their pre exercise and post exercise value (SEBT) of eight directions noted. Their data analyzed by paired sample t-test were found statistically significant for Lateral (0.05), Posterior, Posterior Medial, Medial direction ($p<0.001$), while such values were found non-significant for four directions (Anterior, Anterior Lateral, Postero Lateral and Anterior Medial) further details are shown in Figure.4 (A).The subjects in Control Injured Group (n=48) were having acute or chronic ankle sprain of one leg. They were at rest and medications as recommended by their doctors. They were (for non-injured leg) evaluated for pre exercise values of eight directions of Star Excursion Balance Test and 8 subjects left the study due to their personal reasons. After 8 weeks the leftover 40 subjects were provided for their post exercise evaluation for non-injured leg for 8 directions of SEBT test. Statistical analysis of pre exercise and post exercise evaluations were noted significant for Lateral ($p<0.01$) and Posterior Lateral directions ($p<0.05$). Remaining six directions (Anterior, Anterior Lateral, Posterior, Posterior Lateral, Medial and Anterior Medial) were showing non-significant changes in their pre exercise and post exercise values Figure.4(B). Pre exercise (n=48) and Post exercise (n=40) evaluations for the subject in Control Injured subject for their injured leg was noted and found a statistically non-significant for Anterior, Anterior Lateral, Posterior lateral, and Anterior Medial directions. The remaining of four directions (Lateral, Posterior, Posterior Medial and Medial) was found statistically significant ($p<0.001$) Figure.4(C). Although the subjects in Aqua Rehab Group (n=49) were with acute and chronic ankle sprain for one leg. Their values for the eight directions of SEBT test (pre-test) for non-injured leg compared the same values after completing 8 weeks of Aqua exercises (i.e the post-test) was found

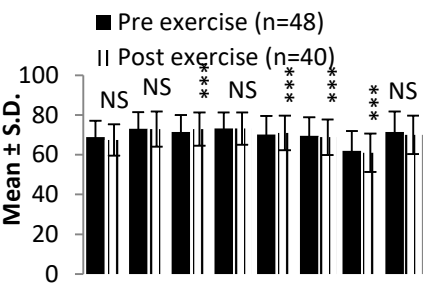
statistically significant. Thereby showing significant improvement Figure.4(D). Pre exercise (n=49) and Post exercise (n=40) values for an injured leg (Acute and Chronic ankle sprain) were found statistically significant ($p<0.001$) for all eight directions Figure.4 (E).

Normal Control (A)

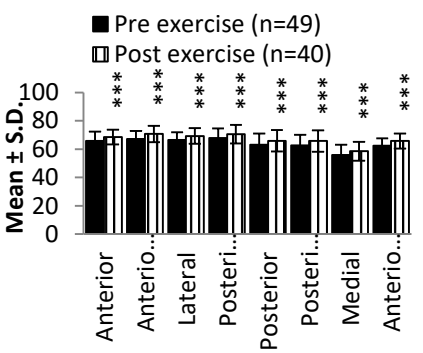


Control injured (non-injured leg, B) Control injured (injured leg, C)





Aqua rehab group (non-injured leg, D) Aqua rehab group (injured leg, E)



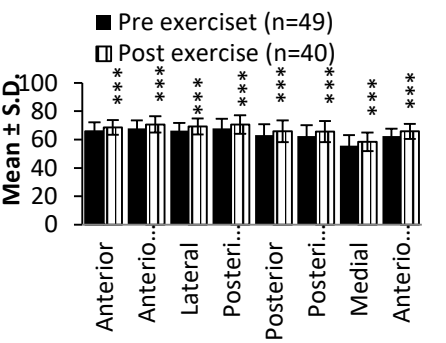


Figure .4 Showing Mean S.D. of pre exercise and post exercise values (cm) of 8 directions of Star Excursion Balance test (SEBT) of Normal Control (A) Control injured (non-injured leg, B; injured leg, C), Aqua group (non-injured, D; injured, E). The subjects were selected from four major cities of Punjab from December 2016 to 2018 December 2016. The data were compared and evaluated by paired

sample t-test found statistically significant at *p<0.05; **p<0.01; ***p<0.001 level.

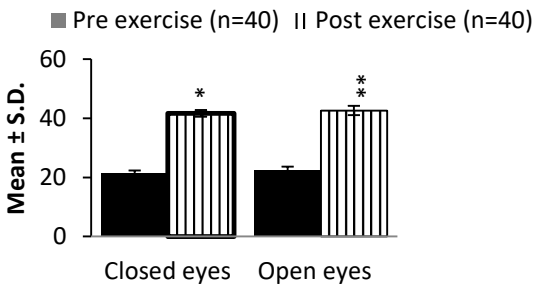
Recurrence

After completing the Aqua exercise plan the subjects were followed for four months to check the recurrence and observed that recurrence of Control Injured and Aqua Rehab Group was 8% and 5% respectively.

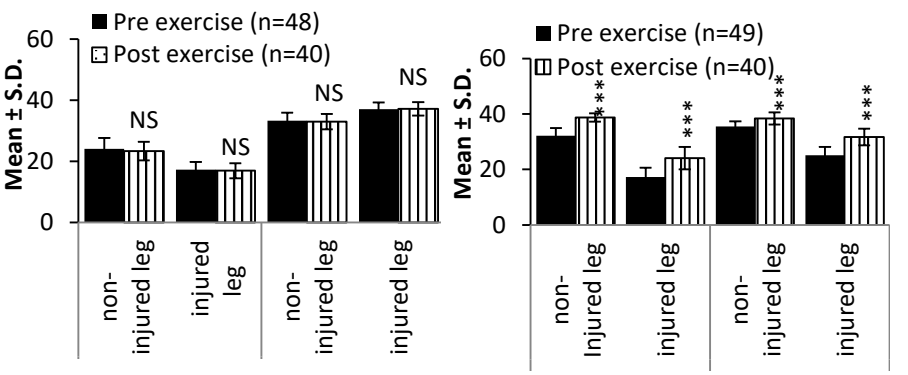
Aqua Rehab Group (Single Leg Balance Test)

The difference between pre exercise and post exercise values (sec) of Single Leg Balance Test of Normal Control (n=40) were noted statistically significant (p<0.05) while balancing with closed eyes and open eyes (p<0.01) as shown in Figure.5 (A).Control Injured Group (non-injured leg) showed non-significant improvement in their pre exercise and post exercise values (sec) while balancing with closed and open eyes as the mean ± S.D. values of these values decreased from 35.1± 2.7 to 34.7 ± 2.4 and 33.2 ± 2.2 to 33.1± 2.4 respectively (Fig 4.5 B). Similar values for injured leg was found non-significant while balancing with close and open eyes Fig.5 (B). The percentage change between pre and post exercise of the Aqua Rehab Group (non-injured leg) results through Single Leg Balance Test indicated that there was an improvement (8.8 and 4.8) percent in both positions Mean ± S.D. values (seconds) of subjects (non-injured leg), changed from 32 ± 2.2 to 34.8 ± 1.4 with a difference of 2.8 with a closed eyes and 35.5 ± 1.9 to 37.2 ± 3, difference 1.7 with open eyes as shown in Figure.5 (C). Subjects in the Aqua rehab group were evaluated after 8 weeks of hydrotherapy exercises (in swimming pool). Their pre exercise and post exercise difference in the values (seconds) of and injured leg showed a difference of 6.8 and 6.6 while balancing with closed and open eyes respectively. The data analyzed by paired sample t-test was found statistically significant (p<0.001) for both values Figure.5 (C).

Normal Control (A)



Control Injured (B) Aqua rehab group (C)



Positions (seconds) Positions (seconds)

Figure.5 Showing Mean ± S.D. of non-injured and injured leg with both positions (balance with closed and open eyes) of Single Leg Balance Test of subjects in Normal Control (A), Control Injured (B) and Aqua Rehab Group (C). Selected from four major cities of Punjab from December 2016 to December 2018. The data compared and evaluated by paired sample t-test was found statistically significant at*$p<0.05$; **$p<0.01$; ***$p<0.001$ level.

Discussion

The purpose of this study was to check the rehabilitation of acute and chronic ankle sprain through Aqua exercises (dorsiflexion, plantar flexion, inversion movement eversion movement and mobilization walking and jogging, standing on one leg with (open and closed eyes)) in Pakistan amateur cricketers. The study found that each direction activated the stance of lower extremity muscle to a different extent. Our study reported that in the Anterior reach the vastus medialis and lateralis were 11.8% more active in non-injured group and 11.3% in injured group respectively. During the Postero Lateral reach the bicep femoris and Anterotibilais were (non-injured, 11.6% and injured, 11.8%) more active. The anterior tibialis was most active in the Posterior Medial reach direction which is

13.5% and 12.8% improved in reach distance as compared with pre exercise as lined the result with similar findings have also been reported by Earl and Hertal (2001,93) while working with lower extremity muscle activation but we are working on rehabilitation of acute and chronic ankle sprain. Posterior Lateral is an important direction in ankle evertor movement, increased activation of the Posterior lateral may help in the stabilization of the ankle and through its attachment to the first tarsal-metatarsal joint (Munn et al, 2003, 245). There is an improvement of (11.6% and 11.8%) improved in reach distance in pre and post exercise as evaluated through SEBT test. Additionally, we also concluded that posterior medial and posterior lateral reaches directly relied on strength as compared with the other direction results are familiar with (Olmsted et al. 2002,2006). Their poor balance also causes the ankle sprain problem as a result was compared with the similar findings have also been reported by (McGuine et al. 2000,239) on balance while predicting of ankle injuries in high school basketball players. Similarly, our present result showed Anterior Lateral, Lateral, Posterior, Medial, Anterior Medial showed improvement (%) of 12.5, 12.9, 12, 11.6 and 14.2 improvement in non-injured leg, while the similar values for injured leg were 14.1, 11.7,12.1,13.2 and 13.2. The 8 weeks aqua training program improved balance and results are same as Gribble et al. (2004,321) reported that decreased in the performance of SLB position was due to the overuse of the hip abductor muscles. Similarly, Miller and Bird (1976,135) have reported that the proximal musculatures are more important than the distal ankle muscles in maintaining body balance. Similarly, in the case of Single Leg Balance Test the individual's overall improvement in the non-injured leg between pre and post exercise results were 4.1 seconds with 6.3% along with 2.7 seconds with 4% in injured leg and for combined group non-injured leg resulted 2.8 seconds with 8.8% seconds for close eyes and for open eyes 1.7 seconds with 4.8%. The improvement in the injured leg in pre and post test results was 6.8 seconds with 39.9% for close eyes and for open eyes 6.6 seconds with 26.1%. Our result indicated that the rehabilitation plan of eight weeks with Aqua exercises improved flexibility, Range of Motion (ROM), mobilization, regain strength, proprioception, isometric strength, isotonic strength and proprioception the result was consistent with findings of Simon et al. (2019,676). The results of individual subjects improvement concluded that the injured leg adopted (5.6%) more improvement as compared with non-injured leg in a case of SEBT. However, SLB test show equal percentage of improvement in both non-injured leg and injured leg, but the variation in data was 0.8 and 1.7 respectively. Their all over improvement difference was 3.1 ± 1 and 3.3 ± 2.2. Similarly, findings with the reported literature are not available for comparison. We found that the Aqua exercise protocol led to a significant increase in ankle muscle strength around the ankle muscle and stabilizers which supported ankle joint (Rahmani et al. 2018,179). The findings were also lined up with the results of (Freeman 1965,669) and (Doherty *et al.* 1993,868) that exercises prevent the functional instability. Moreover, changes in muscle performance with exercise training have been demonstrated to be related to changes in physical function (Caminiti *et al*. 2009,919) in our study a significant difference SEBT test reaches in pre and post evaluation submitted to hydrotherapy, despite the fact that hydrotherapy was shown to be in improving volume of maximum oxygen consumption (VO2 max) and strength. Furthermore,

Chang et al. (2012,500) reported that the hip abductor muscle performance correlates with standing balance performance. Additionally, ankle stability reformed due to improve in the balance position it is because of the proprioceptive training (Clark et al. 2015, 378). The subjects were followed 4-month after implementation of Aqua Rehab program, and observed that 8% in control injured group Control Injured Group and 5% in Aqua Rehab Group followed for four months after the rehabilitation exercises plan.

Conclusion

The study concluded that 8-week Aqua rehabilitation exercises (dorsiflexion, plantar flexion, inversion movement eversion movement and mobilization walking and jogging) significantly reduces pain and recovers efficiently, regain strength, reinstall proprioception and moreover reduce the risk of future ankle sprain by follow the subjects for four months to check the recurrence 8% in control injured group and 5% in Aqua Rehab Group. It is due to the Aqua exercises that improve strength and stability in the muscles that support ankle. However, further studies in this connection are needed.

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