Rehabilitation of Acute and Chronic Ankle Sprain for Male Cricketers through Mixedbag (Hydrotherapy and Land-Based) Exercises

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REHABILITATION OF ACUTE AND CHRONIC ANKLE SPRAIN FOR MALE CRICKETERS THROUGH MIXEDBAG (HYDROTHERAPY AND LAND-BASED) EXERCISES

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ABSTACT

Ninety-five amateur cricketers of age, 15-35 years with confirmed acute or chronic ankle sprain, selected from four different cities of the Punjab, Pakistan were evaluated through Star Excursion Balance Test (SEBT), Single Leg Balance test (SLB) and subject to a set of progressively increasing exercises on ground and in water as well known as MixedBag rehab exercises which consisted of Hydro, Isometric, Isotonic and proprioception protocols. Another group of same level cricketer (n = 40) served as control. Comparisons of pre and post-exercise values showed significant increase (p < 0.001) in Lateral direction reach and Posteromedial direction while the rest of the six directions showed non-significant results. MixedBag Rehab Group showed an overall improvement of 14.3 % and 9.2 % with an increase (cm) of 9.6 and 6.3 for the non-injured and injured leg respectively. However, the range of improvement in percentage for all eight directions lies between 5.5-6.3 and 7.7-11.8 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 in seconds were 2.9, 12.1 and 4.1, 27.7. The results indicated that MixedBag exercises improved isometric and isotonic muscular strength, proprioception and stability that ultimately helped to recover, regaining strength and reinstall proprioception. After completing the MixedBag Rehab plan, the subjects were followed for four months to check the recurrence and it was found that the recurrence of Control Injured Group and MixedBag Rehab Group was 17.5 % and 7.5 %, respectively.

Keywords: Ankle sprain, chronic, rehabilitation, proprioception 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 (Holmes and Lin, 2006; Terada et al., 2013; Lubbe et al., 2015; Doherty et al., 2017). 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 (Drewes et al., 2009; Hadzic et al., 2009; Gribble et al., 2013; Doherty et al., 2017). 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 (Osborne and Rizzo, 2003; Donovan and Hertel, 2012; Kerkhoffs et al., 2012; Lardenoye et al., 2012; Witjes et al., 2012; Mircea and Mariana, 2014).

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 Hertel, 2013).

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, and Sialkot) from December 2016 to December 2018. MixedBag exercise plan (Aqua exercises in water 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. MixedBag exercise session utilized the principle of progression, overloading and specificity for eight weeks. The exercise session increased at least 10 % in every weekly exercise plan (Dubin et al., 2011). The intensity of the exercises was weekly increased till eight weeks from light to high along with two unloaded weeks (4th and 8th).

Hypothesis

The Study hypothesized that rehabilitation through the MixedBag Rehab exercises both hydrotherapy and land-based is an effective method and cut down the recurrence.

MATERIALS AND METHODS

Ninety-five male subjects were selected, their age was 15-35 years, having acute and chronic ankle sprain injury of duration 2 years 2018-2020 passed through the Rest, Ice Compression and Elevation (R.I.C.E) protocol to get rid of initial pain. This study used a selective sampling technique. The data collected from 4 major cities (Lahore, Faisalabad, Gujranwala, and Sialkot) of Punjab Pakistan, 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 MixedBag Rehab Group n=47 randomly. The subjects were medically fit except ankle sprain. The MixedBag Rehab exercise plan was executed in Punjab University Gym/ grounds, 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 Hertel, 2004) and normality was checked through the Shapiro-Wilk test and found data was slightly normal. 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 MixedBag exercises plan on non-

injured and injured leg. Before starting the test, subject was given a verbal and visual demonstration and they performed six practice trials as recommended by Gribble and Hertel (2004). 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 scale(tape) with eight lines marked out from the center at 45º 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 (both legs) 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. The test 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., 2012). The grid is shown in Figure 1.

The subject was standing on non-injured and injured leg on a hard surface near a support as much as the participant can in seconds with open and closed 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 seven subjects from the MixedBag 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 Figure 2 showed the flow chart of the study
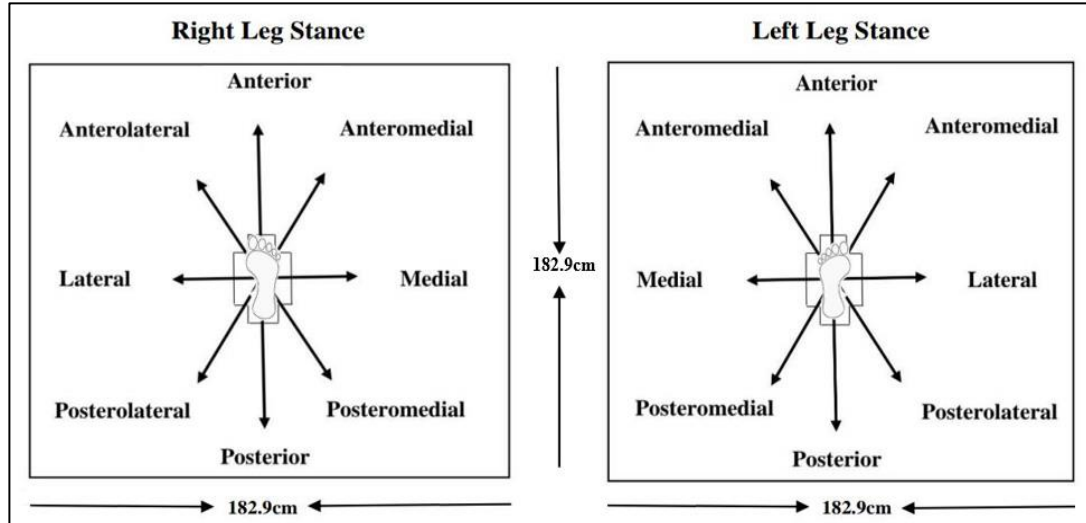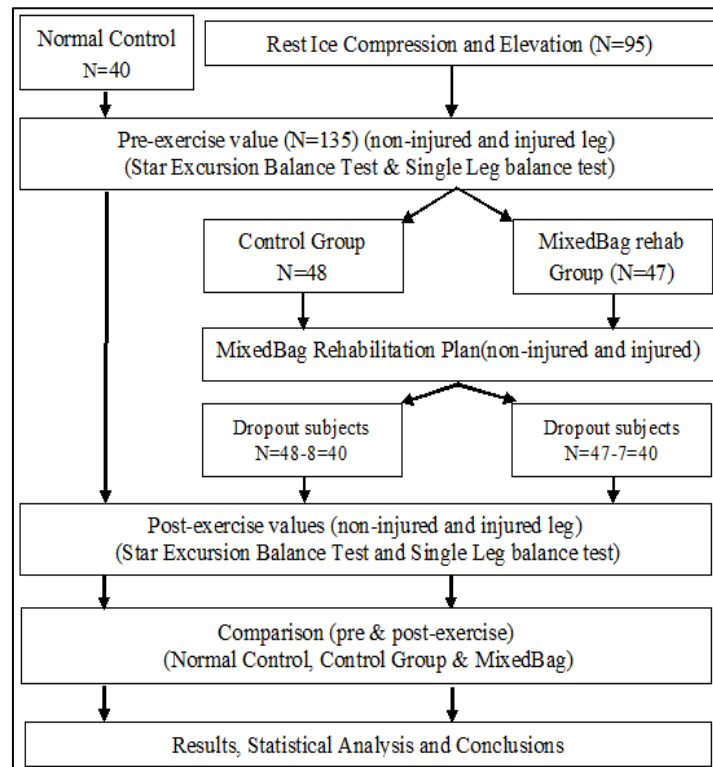

Figure 1. 8 directions (anterolateral, anterior, anteromedial, medial, posteromedial, posterior, posterolateral, and lateral) of the Star Excursion Balance Test of Right and Left leg stance (After Gribble et al., 2012).

Figure 2: Flow Chart showing activities of amateur cricketers (N=95) with Acute and Chronic Ankle Sprain consisted of Normal Control (NC,40), Control Injured (CI,48), MixedBag Rehab Group (M,47) 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).

MixedBag Rehab Group

Before starting the MixedBag rehabilitation plan the subjects (N = 47) 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 MixedBag (hydro & land-based) exercises for the duration of eight weeks. In this duration 7 subjects left the study due to their personal reasons, leaving behind 40 subjects.

MixedBag Rehab Group (Individual Improvement)

The difference between pre and post-exercise results of non-injured leg of the MixedBag rehab group tested through Star Excursion Balance Test indicated that

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there was an improvement (2.5 ± 1.2) % in eight directions. Mean ± S.D. values for pre-exercise (n = 47) and post-exercise (n = 40) showed a change from 67.3 ± 5.6 to 76.9 ± 5.6 with a difference of 9.5 ± 4.5. It showed a mean difference in pre and post-exercise results of the Star Excursion Balance Test (injured leg) with an improvement in all directions. Mean ± S.D. of subjects showed that their pre-exercise (N = 47) and post-exercise (N = 40) values changed from 68.3 ± 5.8 to 74.6 ± 5.4 with a difference of 6.0 ± 1.0 thereby showed percentage increases of 2.5 ± 0.4. 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 (closed and open eyes). Mean ± S.D. values of subjects with non-injured leg, changed from 69.3 ± 3.2 to 72.1 ± 3.4 with a difference of 2.8 ± 0.9 thereby showing improved percentage of 2.5 ± 0.8. The difference between pre-exercise (N = 47) and post-exercise (N = 40) values for a Single Leg Balance Test of injured leg, showed an improvement (2.5 ± 0.9) % while balancing with close and open eyes. These values changed from 43.3 ± 4.3 to 56.7 ± 5.1 with a difference of 13.1 ± 4.6 respectively.

MixedBag Rehab Group

(Star Excursion Balance Test)

The subjects in Normal Control (CI = 40) did not performed any special exercises but they were resuming their normal activities. However, their pre exercise and post exercise value (Star Excursion Balance Test) of eight directions were noted. Their data analyzed by paired sample t-test and were found statistically significant for lateral (p < 0.05), posterior, posteromedial and medial direction (p < 0.001), while such values were found nonsignificant for four directions (anterior, anterolateral,

posterolateral and anteromedial) further details are shown in Figure 3 (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. The subjects were evaluated for non-injured leg, 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 evaluated 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 < 0.001), medial direction (p < 0.05), remaining six directions (anterior, anterolateral, posterolateral, posterior, posteromedial and anteromedial) were showing non-significant changes in their pre exercise and post exercise values (Figure 3 (B)). Pre-exercise (n = 48) and post-exercise (n = 40) evaluations for the subject in Control Injured group (for their injured leg) were noted and found statistically non-significant for anterior, anterolateral, lateral, posterolateral, posterior, medial and anteromedial directions. The results for remaining one direction (posteromedial) were found statistically significant (p < 0.05) (Figure 3 (C)).

Although the subjects in MixedBag Rehab Group (n = 47) were with acute and chronic ankle sprain for one leg. Their SEBT values for the eight directions of SEBT test (pre-exercise) for non-injured leg compared with the same values after completing 8 weeks of isometric strength, isotonic strength and proprioception exercises (i.e. the post-exercise) values were found statistically significant (p < 0.001) for all the directions of SEBT grid. Thereby showing significant improvement (Figure 3. D). However, the present increase for all the eight directions were within the range of 5.5 - 6.3 (Figure 3 D). Pre-exercise (n = 47) and post-exercise (n

= 40) values for an injured leg (acute and chronic ankle sprain) were found statistically significant for all eight directions of SEBT grid. The present increase of all the directions was within

due range of 7.7-11.8. The positive impact of proposed MixedBag exercises method is visible (Figure 3 (E)).

Normal Control (A)

Control injured (non-injured leg, B)

Control injured (injured leg, C)

MixedBag rehab group (non-injured leg, D)

Directions (cm)

MixedBag rehab group (injured leg, E)
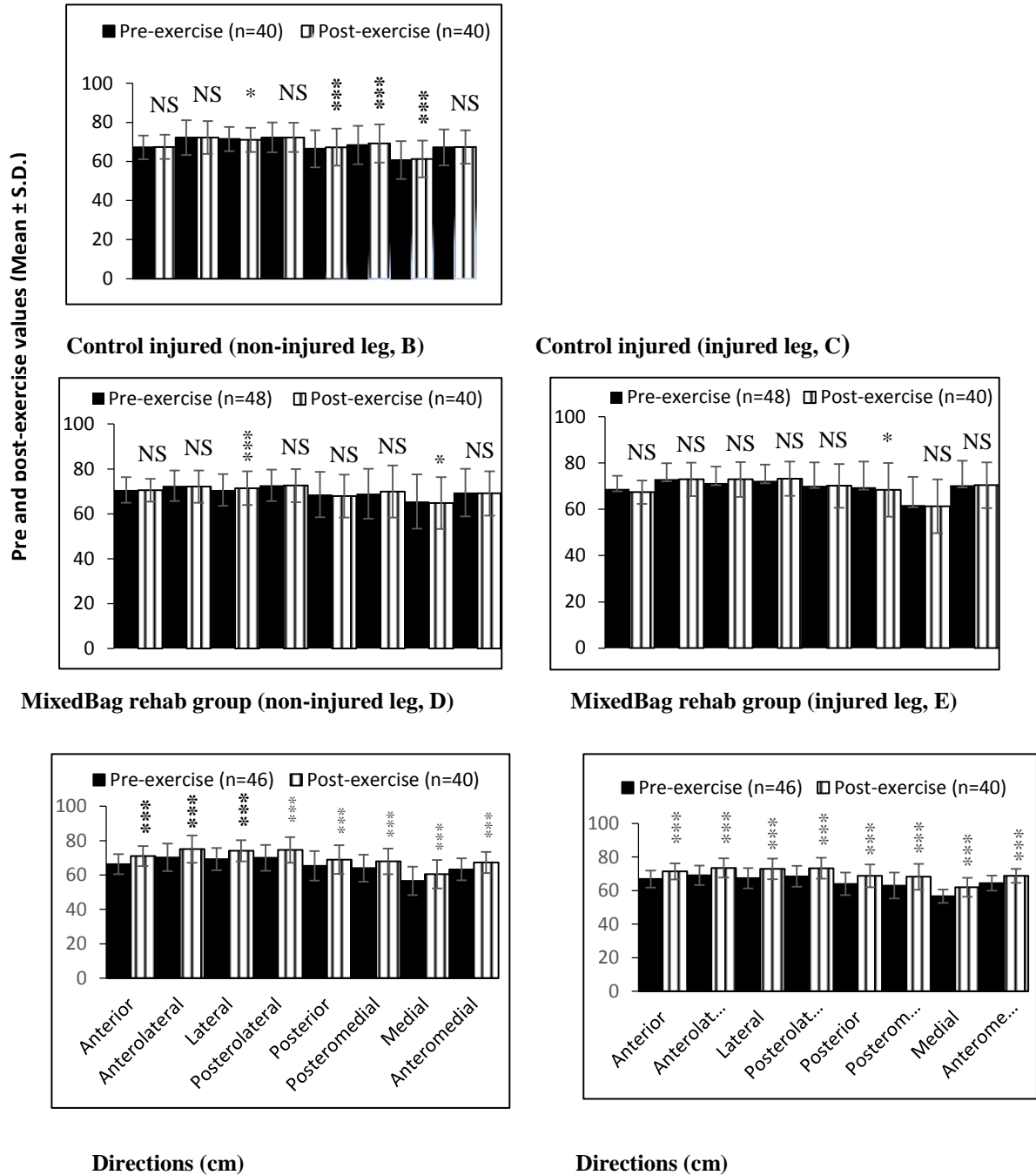
Directions (cm)

Figure 3: Showing Mean ± S.D. of pre exercise and post exercise values (cm) of 8 directions were evaluated by Star Excursion Balance Test (SEBT) of Normal Control (A), Control injured (non-injured leg, B; injured leg, C), MixedBag Rehab Group (non-injured, D; injured, E). The subjects were selected from four major cities of Punjab from December 2016 to December 2016. 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.

Normal Control (A)

Control Injured Group (B)   **MixedBag Rehab Group (C)**

(seconds)
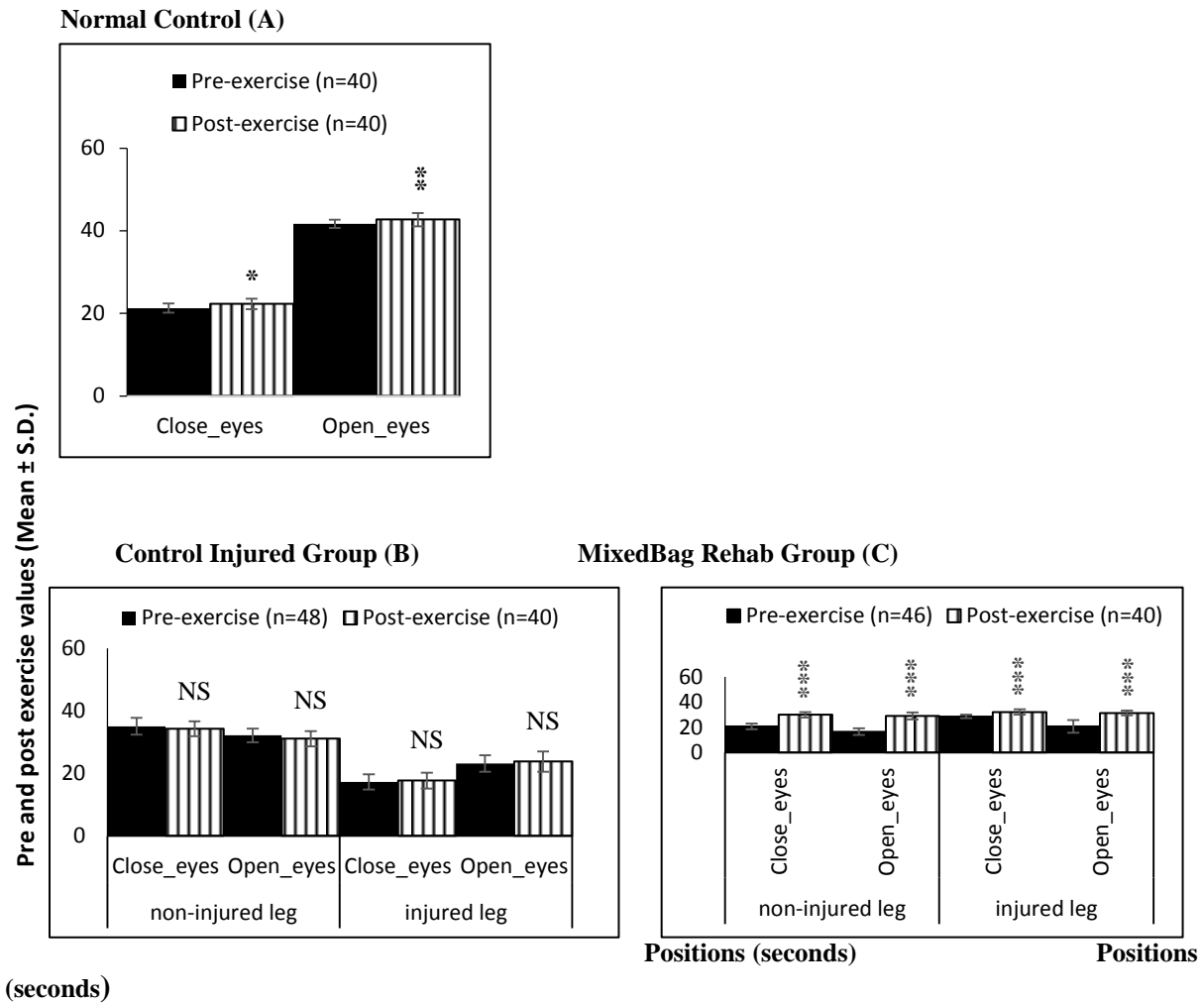
Figure 4: Showing Mean ± S.D. of two positions balance with close eyes and open eyes of Single Leg Balance Test of subjects in Normal Control (A), Control Injured (B) and MixedBag rehab group (C). Subjects were selected from four major cities of Punjab from December 2016 to December 2018. The data compared and evaluated by paired sample t-test was found statistically significant at *p < 0.05; **p < 0.01; ***p < 0.001 level.

MixedBag Rehab Group (Single Leg Balance Test)

The difference between pre-exercise and post-exercise values (sec) evaluated through Single Leg Balance Test (SLB) of Normal Control (n = 40) was noted statistically significant (p < 0.05) while balancing with closed eyes and open eyes (p < 0.01) as shown in Figure 4 (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 decreased from 35.1 ± 2.7 to 34.3 ± 2.4 and 32.2 ± 2.2 to 31.1 ± 2.1 respectively (Figure 4.B).

Similarly, values for the injured leg were found non-significant while balancing with closed eyes and open eyes (Figure 4.B). The change of percentage between pre and post-exercise of the MixedBag rehab group results through Single Leg Balance Test indicated that there was an improvement of 53.8 and 15.5 percent in both positions (closed and open eyes). Mean ± S.D. values (seconds) of subjects non-injured leg (closed eyes) changed from 25.1 ± 3.1 to 38.6 ± 3.2 with a difference of 13.5 with close eyes and injured leg 32.9 ± 1.9 to 38 ± 2.3 with a difference of 5.1 as shown in (Figure 4.C). Subjects in the MixedBag rehab group were evaluated after 8 weeks of the

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proposed method of MixedBag exercises (dorsiflexion, plantar flexion, isometric holds against the wall, inside and outside isometric hold, plantar and dorsiflexion mobilization, single leg stance with closed eyes and open eyes) on ground and in the pool as well. Their pre-exercise and post-exercise difference in the values (seconds) of injured leg showed a difference of 17.1 and 13.7, improvement with a change percentage 96.6 and 53.9 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 4.C).

DISCUSSION

The MixedBag rehab group consisted of a combination of exercises (Hydro exercises, isometric, isotonic and proprioception exercises) rehab protocols. The MixedBag rehab group showed maximum enhancement in ankle rehab instability, which was measured through the Star Excursion Balance Test (SEBT) dynamically and statically Single Leg Balance (SLB) respectively. The hitches of combination (Aqua and Headway) rehab group were minimized by the combination of both group exercises as it copes with the characteristics of both rehab groups. The maximum improvement in the MixedBag rehab group not only showed its importance but it also showed a relatively less recurrence rate as compared with the other two rehab exercises method. This study reported that the anterior direction of the MixedBag rehab group showed an improvement of 8.4 % in non-injured and 11.5 % in injured rehab group as pre and post-exercise results were compared. The anterior direction showed maximum improvement as it was associated with the activation of many muscles, e.g. tibialis anterior, peroneus brevis and longus along with bicep femoris. Similar results were also reported by Earl and Hertel (2001), Ahn et al. (2011), and Karagiannakis et al. (2020) based on their work on lower

extremity muscle activation and assessed through SEBT.

The anterolateral direction was improved and its percentage was 7.5 and 13.8 for the non-injured and injured leg. The present MixedBag rehab study also indicated that the anterolateral direction improvement was associated with the enhancement in the tibialis anterior and peroneus longus muscles as it was also maintained by Earl and Hertel (2001), Ahn et al. (2011) and Karagiannakis et al. (2020).

The improvement percentage of lateral direction was 8.5 and 12.9 for the non-injured and injured leg. The lateral direction was improved due to the enhancement in the performance of anterior tibialis muscle, vastus lateral and bicep femoris. This is in line with the results of Earl and Hertel (2001), Ahn et al. (2011) and Karagiannakis et al., (2020). The posterolateral direction improved by 9.0 % for non-injured and 13.8 % for injured legs. The present study indicated that the betterment in the posterolateral direction was because of the improvement of tibialis posterior, anterior tibialis and soleus muscles activation as it was also maintained by Earl and Hertel (2001), Ahn et al. (2011) and Karagiannakis et al. (2020).

The improvement of posterior direction was 9.2 % and 17.8 % and it was associated with the enhancement of the anterior tibialis, tibialis posterior and soleus muscles, which was also described by Earl and Hertel (2001), Ahn et al. (2011), and Karagiannakis et al., (2020) while they worked on lower extremity muscles activation with SEBT protocol.

The posteromedial direction showed an improvement of 9.2 % and 15.2 % for the non-injured and injured leg, respectively, in the MixedBag rehab group. The present investigation showed that posteromedial is an important direction and its improvement depends upon the enhancement of anterior tibialis, tibialis posterior and soleus muscles. This

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is also similar to the findings of Earl and Hertel (2001), Ahn et al., (2011) and Karagiannakis et al. (2020) as they worked on ankle muscles activation with SEBT protocol.

The present investigation showed that medial direction improvement for the non-injured and injured leg was 10.6% and 16.1 % respectively. The study indicated that the improvement in medial direction was due to an enhancement in the performance of the anterior tibialis muscle. Similar finding was also reported by Karagiannakis et al. (2020) as they worked on ankle muscles activation with SEBT protocol of healthy individuals.

The MixedBag rehab study showed that the improvement in anteromedial direction was 8.6% and 12.2 % for the non-injured and injured leg respectively. The present study regarding MixedBag rehab group showed that the improvement in anteromedial direction was associated with tibialis anterior and peroneus longus muscle, which was also stated by Ahn et al. (2011) and Karagiannakis et al. (2020) in their study on ankle muscle activation through SEBT protocol.

Our MixedBag rehab study proposed that the combination of hydrotherapy and land-based exercises (Aqua rehab and Headway rehab exercises) may improve the static balance of ankle sprain subjects. This was also reported by Nualon et al. (2013) as they worked on chronic ankle athletes and also assessed static balance with SLB test protocols. Similarly, the MixedBag group showed a gradual improvement in Isometric and isotonic strength, range of motion (ROM) and balance. This was also reported by Abadi et al. (2018) while they worked on ankle sprain athletes and showed progressively better results in ROM and balance positions of ankle. Moreover, the combination of aquatic and land-based training showed significant an improvement along with an enhancement in the performance of both static and dynamic protocols which resulted in the

stability in lower extremity ankle sprain injury. The similar result was also reported by Mushtaq and Suresh (2019) based on their work on tennis players. Furthermore, the present study recommended that the impact of both protocols (Aqua and Headway rehab exercises) combined showed maximum improvement as compared with Aqua and Headway rehab group independently. Similar finding was also reported by Ragab (2020) as they worked on individual methods of hydrotherapy versus a combination of both (Aquatic and land-based) therapies in the treatment of ankle sprain.

The present study of 24 sessions of the MixedBag rehabilitation program measured the injured leg static balance with Single Leg balance protocol and concluded an improvement in both positions (closed and open eyes) which was 96.6 % and 53.9 % respectively.

The present investigation stated that the improvement in static balance with closed eyes was 96.6 % and 53.9 % for injured leg with open eyes respectively. The result was in line with Mckeon et al. (2008) and Alahmari et al., (2020). They both measured the static balance of ankle sprain subjects through SLB protocols.

Additionally, in the case of the SLB test, the individual's overall improvement of the MixedBag rehab group (non-injured and injured leg) between pre and post-exercise showed the same level of improvement that was 2.5 %. For closed eyes (non-injured) resulted in 53.8 % improvement for an injured leg; while with open eyes position 15.5 % improvement was recorded.

CONCLUSION

The study concluded that 8 weeks MixedBag 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 17.5% in control injured group and 7.5% in MixedBag Rehab Group. It is due to the MixedBag exercises that improvement in strength and stability of the muscles that support ankle. However, further studies in this connection are needed.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION

SAG and MI drafted the manuscript. RAKS and HI carried out the statistical analysis. SY conduct the field work and helped in data collection. TA overall supervised the work and MTW reviewed and edited the draft.

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