The Effect of MobEx Intervention in University Athletes with Post Lateral Ankle Sprain

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Abstract-As the injury and re-injury to lateral ankle ligaments are common in athletes due to the restricted ankle dorsiflexion range of motion (DROM) and dynamic balance (DB), this study was aimed to find out the effectiveness of MobEx intervention to improve and sustain the DROM and DB. Twenty-seven athletes with history of unilateral LAS were recruited in one of the experimental, placebo and control groups randomly. All of them were assessed for their DROM and DB using weight bearing lunge test and Modified Bass Test for Dynamic Balance respectively as a pre-test score. After this pre-test measurement, the experimental group were intervened by MobEx intervention for six weeks and the placebo group were intervened by placebo intervention for six weeks too. Whereas the control group neither intervened by MobEx intervention nor the placebo Intervention. The DROM and DB were measured after six-weeks for post-test scores and again after one month for retention-test scores. The primary aim was examined with repeated measures of multivariate analysis of variance. The interaction for the repeated measures of multivariate analysis of variance was statistically significant for the DROM and DB in the experimental group (P<0.001), and for the DB in the placebo group (P<0.001). The improvements in DROM and DB were significantly greater at both six weeks and one month in favor of experimental group. The result suggests that the MobEx intervention is effective not only in improving the DROM and DB but also to retain its improved effects.
Keywords: lateral ankle sprain, MobEx, dorsiflexion range of motion, Dynamic Balance.

1. INTRODUCTION

One of the most common sports related lower extremity injury is lateral ankle sprain (LAS) with higher rate of recurrence (van Rijin et al, 2008). The post LAS impairments are often addressed by suitable rehabilitation protocols yet some athletes may remain to exhibit impairments in ankle dorsiflexion range of motion (DROM) (Hertel, 2000; Holme & Delahunt, 2009) which may impact on walking and running gait patterns (Denger, Hertel, Fonseca, 2002) also may possibly contribute to the higher risk of reinjury (van Rijin et al, 2008). The impairment of the ankle DROM may be due to osteokinematic restrictions or arthrokinematic restrictions (Cosby, et al. 2011) and thus decreased ankle DROM. While the osteokinematic ankle DROM may be reestablished following lateral ankle sprains, arthrokinematic restrictions may possibly still be existent (Denger, Hertel, Fonseca, 2002). Alteration in the joint arthrokinematics can eventually influence negatively on gait pattern by showing alterations in the ankle axis of rotation, changes in alignment and tracking of bony surfaces, disturbed proprioceptive input to sensorimotor system (Hoch, & McKeon, 2010) and are supposed to be concomitant with increased risk of ankle osteoarthritis (Denger, Hertel, Fonseca, 2002; Hoch, & McKeon, 2010). Loss or decreased arthrokinematic nature of DROM could also contribute to the functional impairments associated with post LAS by disturbing the normal transmission afferent information available to the sensory motor system by exhibiting deficits in postural control as a result of a loss in somatosensory information from damaged ligamentous mechanoreceptors (Hertel, 2002; Hoch, & McKeon, 2011). In addition, conversely these sensory inputs alteration may correspondingly be associated with arthrokinematic changes (Hoch, & McKeon, 2011; Wikstrom, & Hubbard, 2010; McKeon, et al. 2010) thus, the restricted DROM affects the balance (Hoch, Staton, & McKeon, 2011).

Lateral ankle ligaments are susceptible to be injured in combined motion of plantar flexion and inversion mechanism (Hertel, 2002). Following LAS, limited DROM has been associated with a lack of posterior glide of the talus on the tibia (Hertel, 2000; Vicenzino, et al. 2006) and this may be related with a positional fault by anteriorly positioned talus due to the disruption of ligaments (Mulligan, 1995; Hertel, 2000; Vicenzino, et al. 2006). To discourse this mechanical impairment, mobilization with movement (MWM) as described by Mulligan (1995) was utilized to increase arthrokinematics and DROM by various researchers (Collins, Teys, & Vicenzino, 2004; Vicenzino, et al. 2006; Reid, Birmingham, & Alcock, 2007). This was achieved by increasing the extensibility of the non-contractile structures (Maitland, 1977). This kind of mechanical impairment was corrected by improving the DROM of the ankle joint along with the functional impairment by improving static control merely (Hoch, & McKeon, 2010) through joint MWM as an immediate effect. However, previous studies (Vicenzino, et al. 2006; Delahunt, Cusack, Wilson, & Doherty, 2013; Mau, & Baker, 2014) have not shown any long-term effects by applying this kind of mobilizations. In general, the proprioceptive balance exercises are used to manage the functional impairment in post LAS as the impaired joint mechanoreceptors reduces its proprioceptive inputs after a LAS (Hertel, 2002; Hoch, & McKeon, 2011) and managed to have a long-term effect (McKeon et al. 2008; Han, et al 2015).

According to Hertel (2000), the mechanical and functional impairments are common in post LASs. As restricted dorsiflexion range of motion have shown to affect the balance (Hoch, Staton, & McKeon, 2011), consequently these impairments need to be addressed simultaneously in order to accomplish a long-term effect on DROM and postural control. Hence, the effects of multiple sessions of mobilization with movement combined with proprioceptive exercises need to be determined to gain and retain the improved DROM and the postural control. In line with this, the current study was aimed to carry out to find out the immediate and continuing effect of MobEx intervention on ankle dorsiflexion range of motion and dynamic balance in athletes with previous history of lateral ankle sprain. In this context, the results of this study may possibly be beneficial in improving and retaining the DROM and dynamic balance, thus reducing the recurrence of LAS and other consequences in addition.

2. RESEARCH METHODS

Twenty-seven male and female athletes participating in non-combat sports from 19 years to 26 years old, representing university in organized sports with previous history of unilateral lateral ankle sprains were recruited for this study. The athletes with bilateral LAS, any history of ankle surgery, had received any manual therapy for the ankle sprain were excluded from this study. The subject recruitment was purely voluntary and recruited through advertisement posters. The subjects were explained about the research procedures and informed consent were obtained from all the study subjects. Throughout the study Helsinki ethical principles were strictly adhered. Single blinded randomized controlled design was used to test the hypothesis with three levels (experiment, placebo, and control) and time at three levels (pre-test, post-test, and retention-test). Thus, the study subjects were randomly assigned into experimental group (n=9), placebo group (n=9) and control group (n=9).

Weight bearing Lunge Test was used to assess the dorsiflexion range of motion (DROM). A sports tape marker was placed 10 cm away from the wall. The subjects were asked to place the great toe on the marker so that he or she can maintain this lunge position during the test period and asked the subjects to touch the wall by his or her knees. If the subjects were not able to touch the wall, then they were asked to move the great toe little bit further until the subjects were able to touch the wall. Then the distance of the great toe to the wall were measured to its nearest decimal were recorded. Modified Bass test for Dynamic Balance; a multiple hop test was used to measure the dynamic balance (DB) of the subjects. The subjects were required to jump from one tape mark to another tape mark in numbered sequence, using injured leg. Five points for landing successfully on the tape mark (tape completely covered by foot), one point for each second (up to 5 seconds) the steady position was held on the tape marks were given. A maximum of ten points per tape mark and 100 points for the test could have been earned by test subjects as explained by Jonson and Nelson (1986).

Along with the demographic specifics the DROM and the DB were measured and recorded before the six weeks of intervention as pre-test scores. MobEx Intervention was introduced to the subjects in the experimental group for a prescribed period time. The MobEx intervention was a combination of mobilization with movement and proprioceptive balance exercises. The subjects received MWM in a standing position on a treatment couch with lower extremity in front with semi flexed position at the knee joint and the other lower extremity of the subject placed on the treatment couch, the researcher used to grasp the mortise region of the sprained ankle with the web space between the thumb and index finger and apply the mobilizing force superiorly and anteriorly at talocrural joint. While doing so, the researcher instructed the subject to move his/her other leg forward and backward as in walking. This maneuver was indicated when it was pain free for the subject. This was delivered for three sets of eight repetitions each at first visit and the repetitions were increased to 15 per set at the end of six weeks. After this, the subjects were performed proprioceptive balance exercise training. Proprioceptive balance exercises were a group of exercises designed based on the integrated balance training programme. The difficulty levels of these exercises were ranged from easy to hard. At the first week, the subjects were needed to perform the easy tasks and progressively the difficulty level was increased to the maximal tolerance level of the subject at the week of six. Prior and after performing the proprioceptive balance exercises, all the subjects were carried out warming-up sessions and cooling down exercises, respectively.

The subjects in the placebo group were used to receive placebo mobilization intervention which was alike procedure of mobilization with movement as explained earlier but without any form of mobilizing force. After this manoeuvre these subjects were also received the proprioceptive balance exercises as same as the subjects in the experimental group. On the other hand, the subjects in the control group they did not receive either of these interventions. After the six weeks of intervention, the DROM and DB were measured for all the subjects and recorded as post-test scores. After a month, these variables were measured again on all the subjects and recorded as retention-test scores. To test the statistical significance in ankle DROM and DB between the experimental group, the placebo group, and the control group a repeated measure of MANOVA by using SPSS version 23 (SPSS Inc., Chicago, IL) was employed. A Tukey's Honestly Significant Difference post-hoc test was also performed to determine where the significant differences occurred across the study groups. A priori alpha level for significance was set to $p < .05$

3. RESULTS AND DISCUSSION

The mean age, height, weight and body mass of the experimental group, placebo group and control group are listed in the Table 1.

Table 1 Demographic Characteristic factors for Subjects with Previous History of LAS

Variables	Experimental Group n=9 (mean ± SD)	Placebo Group n=9 (mean ± SD)	Control Group n=9 (mean ± SD)
Age (years)	23.22 ± 0.83	23.11 ± 1.36	22.44 ± 1.13
Height (centimeters)	160.55 ± 8.61	167.22 ± 11.48	168.00 ± 9.38
Weight (kilogram)	61.48 ± 10.03	68.33 ± 14.72	65.55 ± 7.95
Body Mass Index	23.71 ± 2.28	24.23 ± 3.35	23.20 ± 2.12

The results of interaction and main effects indicated that there was a significant difference in DROM ($F_{4, 46}$ = 26.176, p=0.00) ($F_{2, 24}$ = 13.331, p=0.00) respectively. For the DB, the interaction effects ($F_{4, 46}$ = 16.866, p=0.00) and main effects $F_{2, 24}$ = 25.938, p=0.00) were also significantly different from the pre-test scores. As both dependent variables were exhibited optimistic interaction and main effects, the post-hoc analysis were performed. The post-hoc analysis were showing significant differences between the experimental group, placebo group and control group over ankle DROM and DB. These progressive results were moreover supported by showing no significant differences between the placebo and control groups over ankle DROM. Thus, the interaction effects result demonstrates the positive impact of the MobEx intervention programme that was carried out on experimental group. Regardless of these favourable results, there was significant difference also observed between placebo group and control group on the DB correspondingly. The outcome measures are presented in Table 2.

Table 2 Ankle Dorsiflexion Range of Motion, and Dynamic Balance

	Experimental Group			Placebo Group			Control Group			
	Pre	Post	Ret	Pre	Post	Ret	Pre	Post	Ret	P value
Dorsiflexion Range of Motion (cms)	9.33 ± 1.03	12.71± 1.23	12.52 ±1.23	9.22 ± 1.09	9.22 ± 1.28	8.89±1 .17	9.28 ± 1.30	9.00 ± 1.23	8.83± 1.28	0.00
Dynamic Balance (points)	67.41± 4.86	88.11± 3.65	86.74 ±4.66	67.03 ± 5.15	80.63± 6.20	73.33± 6.44	67.44± 4.71	65.96± 6.63	62.18 ±6.54	0.00

Note: Pre = Pre-test score; Post = Post-test score, Ret = Retention-test score

Bearing in mind the encumbrance of reinjure rate of lateral ankle sprain among athletes because of the reduced dorsiflexion range of motion and postural stability, this six weeks of MobEx intervention programme was aimed to investigate its effect on dorsiflexion range of motion and dynamic balance among university athletes. The findings of this study have revealed that multiple sessions of progressive MobEx intervention program resulted in improving the DROM and DB among athletes who had received MobEx intervention. The results of current study shown significant improvement in DF ROM on athletes as similar to previous studies while applying MWM to the talocrural joint following LAS (Delahunt, Cusack, Wilson, & Doherty, 2013; Mau, & Baker, 2014) and indicated that application of MWM may be attributable to have mechanical effect rather than a hypoalgesic effect. In contrast, the placeobo group and control group did not show any significant improvement in DROM. This supports that, when the arthrokinematic movement from MWM introduced to the ankle joint, the DROM was able to improve significantly on athletes with post LAS. Consequently, the result of current study also showing the same pattern of association to overcome the positional fault and suggesting that, the arthrokinematic movements are indispensable to produce the osteogenic movement (Denger, Hertel, & Fonseca, 2002; Vicenzino, et al. 2006).

However, the previous studies studies (Vicenzino et al. 2006; Delahunt, Cusack, Wilson, & Doherty, 2013; Mau, & Baker, 2014) has proven the efficacy of joint mobilization on initial gains in DROM, the long term effects were still not unblemished as these effect could be mechanical rather than any other mechanism. Though the practice of mobilization also has some effect on sensorimotor sytem functions (Maitland, 1997; Hoch, & McKeon, 2010) to retain the gained mechanical effect the investigators assumed that an additional stimulus to the sensorimotor systems was essential. Thus, proprioceptive balance exercises were assimilated along with the MWM applications to retain the gained DROM. Consequently the results of the current study has shown that the athletes in the experimental group were able to retain the gained DROM even after one month. This is very clearly explained by comparing the results of experimental group with the placebo and control groups. The athletes in both the placobo group and control group were neglected to show any improvenmts in DROM even immediatley affer MobEx intervention. Thus the results of this study asserts that, though the appliation of mobilization with movement could instigate mechanical effect initially, simultaneous additional propricopetive inputs are needed to the sensorimotor system to retain the gained mechanical effects.

As restricted dorsiflexion range of motion have also shown to affect the balance (Hoch, Staton, McKeon, 2011) the results of current study showed that significant improvement in DB among athletes in experimental group after MobEx intervention because of the impact of the proprioceptive balance exercises. This is also clearly evident as the athletes in placebo group also had a significant improvemnet in DB after six weeks of placebo intervention where the athletes predominately recevied the proprioceptive balnce exercises. Several previous studies on proprioceptive balnce interventions have reported improvement in the balance ability and its substantially as well (McKeon, et al. 2008; Han, et al. 2015; Schiftan, Ross, Hahne, 2015). The results of the present study also refelecting the same form of the results with the previous studies by showing immedialte improvement in DB and the sustainability over the athletes in experimental group and placebo group.

Yet, the application of MWM might have some sensorimotor effects, the results of this study indicates that the improvement of DB in experimental group were not only because of MWM but also by means of the incorporated proprioceptive balance exercises in MobEx intervention programme. It is evidently explained by showing the same result in the placebo group were the athletes also reported improvement in DB after receiving the propricocpetive balance exercies along with placebo mobilization with movement. While the athletes in placebo group were able to retain the DB but there was no improvement in the DROM even immediately after the placebo intervention. Though, this finding is contradict with the previous study (Hoch, Staton, McKeon, 2011), the results of the current study is able to show the some reduction of DROM and DB mean values in the placebo group, yet which is not significant to have an effect. This may be in facts that the balance was measured in different approaches. Nonetheless, this current study signifies the value of mobilization with movement to address the DROM due to arthrokinematic restrictions over the ankle joint in post LAS and proprioceptive balance exercises to address the sustainability of dorsiflexion range of motion and dynamic balance in post LAS.

4. CONCLUSION

In line with the results and discussion of this current study, it can be concluded that both the mechanical and functional impairments in post LAS are need to be addressed properly in order to improve and retain the dorsiflexion range of motion and postural ability. Thus, this kind of intervention programme can be employed to deliver approriate care to the athletes to reduce the incidence of LAS. Though this intervention programme has accomplished to gain and sustained dorsiflexion range of motion and dynamic balance in athletic community, it is limited with the its corrective mechanisms. Since the aim of the study was to findout the effectiveness of the intervention program, the underlying mechanisms were not estabilished in this study. Thus, in future the exact mechnisms are to be indentified for better understanding. Since this intervention program is effective in athletic community, this intervention programm can be introduced to the athletes with post LAS during a game season to test its effectiveness in relation with the injury rates. In addition to that, this kind of interventions can be formulated and examined in other populations as well.

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