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"ANKLE DISABILITY IN YOUNG COLLEGE STUDENTS AFTER LOCKDOWN"

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ABSTRACT

The incidence of soft-tissue injuries has increased due to increased physical fitness and recreation. Ankle disability is a common injury, with 70-85% of these sprains being inversion type or lateral ankle sprains. Repeated sprains can lead to residual or chronic ankle instability (CAI), characterized by recurrent ankle disability and a feeling of ankle 'giving way'. CAI can be caused by mechanical, functional, or a combination of both. This research study involved 17 participants with self-reported unilateral CAI, aged 18-35, from the University of Toledo community. Participants had a history of at least one acute ankle sprain, causing or disrupting daily activities for at least one day. Participants were excluded if they had a history of lower extremity injuries, surgeries, fractures, or active pain anywhere but the ankle. Participants were also excluded if they had a history of low back pain within the past six months, narcotics, ibuprofen, caffeine, or exercise within 8 hours of data collection.

For the control group, pre-and post-WB-DF measurements resulted in a large effect size, and the effect of the control intervention on self-reported stability and function scores were moderate. A regression analysis was performed to determine if the variances in self-reported variables and the measures of DF would predict the variance in the pre-post change in anterior reach direction of the SEBT. The study found that self-reported pain and stiffness were the greatest contributors of the increase in anterior reach distance of the SEBT following a posterior glide JM.

INTRODUCTION

The incidence of soft-tissue injuries has increased owing to greater emphasis on physical fitness and recreation. 1 In both athletic and non-athletic population, Ankle Disabilityare a fairly common injury2 and 70-85% of these sprains are inversion type or lateral ankle sprains.1,2 Individuals who suffer repetitive sprains have been reported to have residual instability or chronic ankle instability (CAI). It is characterized by recurrent Ankle Disabilityand a feeling of ankle 'giving way'.

CAI may be caused due to mechanical ankle instability, functional ankle instability or a combination of both.5 Pathologic laxity, impaired arthrokinematics and synovial and degenerative changes cause mechanical instability 5,6 whereas impairments in proprioception, strength & neuromuscular control lead to functional instability.

MATERIAL METHODS

Experimental Design

This research study was a single-blinded, randomized control trial with one between factor (2 levels: intervention and control) and one within factor (pre- and post- intervention). The main outcome measures were DF ROM, dynamic postural control andself-reported patient outcomes. Factors contributing to the performance of the SEBT in individuals with were also determined.

Independent Variables

1) Group
a. Intervention
b. Control
2) Time
a. Pre
b. Post

Dependent Variables

1) Absolute Change Scores for:
a. Ankle DF ROM
1. NWB Active DF Measurement (degrees)
2. WB Lunge Measurement (cm)
b. SEBT- 3 directions (the normalized reach distance: %MAXD) andcomposite reach
c. Self-Reported Patient Outcomes
1. VAS (cm)
i. Pain
ii. Stiffness
iii. Stability
iv. Function

Participants

Seventeen participants with self-reported unilateral CAI, between 18 and 35 yearsof age, were recruited from the University of Toledo community. We included participants with a history of at least one acute ankle sprain causing or disrupting daily activities for at least one day due to pain, swelling, an inability to move or stand, and a loss of function. The most current ankle sprain must have occurred at least six months prior to the inclusion in this research study. Within the past three months, the participant had to have at least two episodes of feeling of giving way or being unstable. The participant was included if he or she scored below a 90% on the FADI and scored below an 80% on the FADI Sport subscale.[63] This questionnaire has been proved to be reliable at detecting functional limitations in individuals with CAI.[63] Furthermore, participants completed a health history questionnaire to detect the presence of a balance disorder, vestibular disorders, headaches, history of concussions or any other disorder or condition affecting the neural system. Participants were also excluded if there was a history of anylower extremity injuries (besides an ankle sprain), surgeries, fractures, or active pain anywhere but the ankle. Exclusion from this study also occurred if participants receivedany treatment or rehabilitation for a lower extremity injury in the past six months.

Diagnosis of joint hypermobility or connective tissue disorders resulted in the exclusion of the participants with these pathologies. Participants with a history of low back pain within the past 6 months were excluded from this study. Participants were excluded if narcotics were being used or if ibuprofen had been ingested within 24 hours. The participants were not permitted to consume caffeine or exercise within 8 hours of the datacollection.

The participants were randomly allocated into two groups: intervention or JM group (n= 9) and control group (n= 8). This allocation was determined by concealed envelopes prepared by an investigator.

All participants signed an informed consent form approved by the University of Toledo Institutional Review Board at the beginning of the pre-treatment testing session.

RESULT

There were no statistically significant group differences in the Age (t_{15} = 1.105, p = 0.29), Mass (t_{15} = 1.57, p = 0.14), FADI (t_{15} = -1.33, p = 0.20) and FADI sport instruments (t_{15} = -1.22, p = 0.24) at baseline (Table 3.1). This indicates that there was no difference in the age, mass, and degree of self-reported impairment in ankle joint functionbetween the JM and control groups. There was a significant difference in height betweenthe groups (t_{15} = 2.38, p = 0.03), with the JM group being taller than the Control group at baseline.

Comparison of the Joint Mobilization and Control Groups

Means, standard deviations, and effect sizes of absolute change scores of all dependent variables are found in Table 4.1. A positive value for the effect sizes for all reach directions of the SEBT and DF measures indicates a better outcome when comparing the JM to the control group. A negative value for the effect sizes for all self-reported patient outcomes indicates a better outcome.

Normalized Reach Distances of the SEBT

No statistically significant group differences were found in the absolute change scores for %MAXD for any of the SEBT scores. However, for the anterior reach, the JM group had observable improvements (1.74 ± 1.91) compared to the control group (-0.46 ±2.66) that was not statistically significant (t_{15} = 1.98, p = 0.07), but did have a strong associated effect size (*d*= 0.96). All other effect sizes were small (<0.39). The 95% CIs for all of the SEBT reach directions crossed 0 (Table 4.1).

Ankle Dorsiflexion Range of Motion

There were no significant group differences in DF using the NWB-DF ($t_{10.84}$ = 1.82, p = 0.10) or the WB-DF (t_{15} = 0.06, p = 0.95) measurements. The large effect size for NWB-DF did support a greater improvement in DF in the JM group compared to the control group, but its associated 95% CI crossed zero (*d* = 0.85, 95% CI = -0.19, 1.79). The effect size for WB-DF was small and its associated 95% CI also crossed 0 (*d*= 0.03,95% CI= -0.92, 0.98).

Self-Reported Patient Outcomes

There were no statistically significant group-differences in any of the self- reported patient outcomes (Table 4.1). However, there was a nearly significant differencein the absolute change of pain (t_{15} = -2.02, p = 0.06) between the JM and control groups. However, a strong effect size (*d*= -0.98) supported that the JM group had a reduction in pain compared to the control group, while the other self-reported measures had small effect sizes. However, all 95% CIs for self-reported patient outcomes crossed 0 (Table 4.1).

Table 4.1. Absolute Change Scores of All Dependent Variables for Joint Mobilization (JM)and Control Groups (Mean ± SD).

		Control	t(15)	P-value	ES (95%CI)	Power
SEBT (%MAXD)						
Anterior	1.74 ± 1.91	-0.46 ± 2.66	1.98	0.07	0.96 (-0.09, 1.91)*	0.62
PM	0.55 ± 4.01	0.01 ± 4.06	0.27	0.79	0.13 (-0.83, 1.08)	0.09
PL	3.12 ± 7.48	2.07 ± 4.39	0.35	0.73	0.17 (-0.79, 1.11)	0.01
Composite	1.80 ± 3.63	0.54 ± 2.78	0.80	0.44	0.39 (-0.59, 1.33)	0.20
Ankle DF						
NWB (°)	3.71 ± 6.04	-0.29 ± 2.47	1.82#	0.10	0.85 (-0.19, 1.79)*	0.57
WB (cm)	0.81 ± 1.77	0.74 ± 2.90	0.06	0.95	0.03 (-0.92, 0.98)	0.06
Self-Reported Patient Outcomes on Visual Analog Scale (cm)						
Pain	-1.71 ± 3.03	0.58 ± 1.06	-2.02	0.06	-0.98 (-1.94, 0.07)*	0.69
Stiffness	-0.73 ± 2.20	-0.20 ± 1.78	-0.55	0.59	-0.26 (-1.21, 0.71)	0.14
Stability	-2.66 ± 2.78	-1.64 ± 1.89	-0.87	0.40	-0.42 (-1.36, 0.56)	0.23
Function	-0.43 ± 1.44	-0.94 ± 1.16	0.79	0.44	0.39 (-0.59, 1.33)	0.20

Comparison of Pre- and Post-Intervention for the Joint Mobilization Group

In addition to absolute change scores of the dependent variables, means, standarddeviations and effect sizes for pre- and post-intervention assessments are provided in Table 4.2 for the JM group and in Table 4.3 for the control group.

The effect sizes for pre- and post-improvement in all of the SEBT reach directions were small for the JM

group, with associated 95% CIs that crossed 0 (Table 4.2). The immediate effect of JM on NWB-DF was moderate (*d*= -0.73, 95% CI= -1.64, 0.26), while the improvement in WB-DF following JM was small (*d* = -0.31, 95% CI= -1.23, 0.63). The effect sizes for pre- and post-improvement in self-reported outcomes ranged from 0.22 to 1.01 following a single application of passive oscillatory JM with 95% CIscrossing zero (Table 4.2).

Table 4.2. Pre- and Post-Intervention Assessments for the Joint MobilizationGroup (Mean ± SD).

	Effect Size	95% CI	Pre	Post
SEBT (%MAXD)				
Anterior	-0.29	(-1.20, 0.66)	63.07 ± 6.10	64.82 ± 6.12
PM	-0.07	(-0.99, 0.86)	84.49 ± 7.98	85.04 ± 7.55
PL	-0.32	(-1.23, 0.62)	79.53 ± 9.46	82.65 ± 10.04
Composite	-0.27	(-1.19, 0.67)	75.70 ± 6.39	77.50 ± 6.79
Ankle DF				
NWB (°)	-0.73*	(-1.64, 0.26)	16.63 ± 5.66	20.33 ± 4.44
WB (cm)	-0.31	(-1.23, 0.63)	8.68 ± 2.51	9.50 ± 2.73
Self-Reported Patient Outcomes on Visual Analog Scale (cm)				
Pain	0.69*	(-0.29, 1.61)	3.67 ± 2.82	1.96 ± 2.06
Stiffness	0.30	(-0.64, 1.22)	3.16 ± 2.49	2.42 ± 2.37
Stability	1.01*	(-0.02, 1.94)	5.09 ± 2.96	2.43 ± 2.27
Function	0.22	(-0.71, 1.14)	3.12 ± 1.85	2.69 ± 2.00

Percentage of Maximum Distance Reached. PM= Posteriormedial. PL= Posteriorlateral. DF= Dorsiflexion. NWB= Non-Weight Bearing. WB= Weight Bearing.

Comparison of Pre- and Post-Intervention for the Control Group

For the control group, pre-and post-improvement effect sizes for all reach directions of the SEBT, NWB-DF, and self-reported pain and stiffness scores were small,with associated 95% CIs that crossed zero (Table 4.3). Pre-and post-WB-DF measurements resulted in a large effect size (*d*= -1.01) and the effect of the control intervention on self-reported stability and function scores were moderate (Table 4.3). However, 95% CIs around the effect sizes crossed 0 (Table 4.3).

Table 4.3. Pre- and Post-Intervention Assessments for the Control Group(Mean ±SD).

	EffectSize	95% CI	Pre	Post
SEBT (%MAXD)				
Anterior	0.08	(-0.91, 1.05)	65.53 ± 5.64	65.07 ± 6.42
PM	0.00	(-0.98, 0.98)	79.11 ± 11.91	79.12 ± 11.00
PL	-0.16	(-1.14, 0.83)	68.41 ± 13.40	70.47 ± 11.57
Composite	-0.06	(-1.04, 0.92)	71.02 ± 9.56	71.56 ± 8.74
Ankle DF				
NWB (°)	0.04	(-0.94, 1.02)	20.67 ± 6.20	20.38 ± 7.01
WB (cm)	-1.01*	(-1.99, 0.08)	9.12 ± 1.87	11.04 ± 1.93
Self-Reported Patient Outcomes on Visual Analog Scale (cm)				
Pain	-0.24	(-1.21, 0.75)	2.19 ± 2.32	2.76 ± 2.40
Stiffness	0.08	(-0.90, 1.06)	3.65 ± 2.31	3.45 ± 2.43
Stability	0.59	(-0.44, 1.56)	4.76 ± 2.83	3.13 ± 2.65
Function	0.55	(-0.48, 1.52)	2.81 ± 2.05	1.88 ± 1.23

Regression Analysis

A regression analysis was performed to determine if the variances in self-reported variables and the measures of DF would predict the variance in the pre-post change in anterior reach direction of the SEBT. The regression analysis was only performed for the anterior reach direction due to no improvements in the posterior directions following the application of the JM. Combination of the absolute change scores for self-reported pain, stiffness, stability and function along with NWB-DF and WB-DF explained 32.6% of the
variance in the improvement in the SEBT performance in the anterior direction (R^2= 0.326, p=0.965). While the absolute changes in NWB-DF alone predicted only 0.1% of the variance of the improvement in anterior %MAXD of the SEBT in the model, the improvement in WB-DF alone explained 5.8% of the variance in the increase in anterior reach distance of the SEBT. After removing variables that were weak contributors to theimprovement in the SEBT performance in the anterior direction, self-reported stiffness remained in the final model and explained 9.2% of variance in the improvement in the anterior reach distance of the SEBT (R^2= 0.092, p= 0.427). However, adding self- reported pain with stiffness increased the predictive value by approximately 15% (R^2= 0.243, p= 0.433). Therefore, following a posterior glide JM, the greatest contributors of the increase in anterior reach distance of the SEBT were self-reported pain and stiffness (24.3%).

Table 4.4. A Multiple Linear Backward Regression Model Predicting the Absolute Change in the Anterior Reach Direction of the SEBT inthe Joint Mobilization Group

Variables	R^2	p	Sx·y	% prediction in Absolute Change in Anterior Direction of SEBTin Joint Mobilization Group
Function, Stiffness, WB-DF, Pain, NWB-DF, Stability	0.326	0.965	3.132	NWB-DF = 0.1%
Function, Stiffness, WB-DF, Pain, Stability	0.325	0.893	2.561	Function = 0.2%
Stiffness, WB-DF, Pain, Stability	0.323	0.755	2.221	Stability = 2.2%
Stiffness, WB-DF, Pain	0.301	0.583	2.018	WB-DF = 5.8%
Stiffness, Pain	0.243	0.433	1.916	**Pain = 15.1%**
Stiffness	0.092	0.427	1.943	**Stiffness =9.2%**

This preliminary study was conducted to evaluate the effectiveness of a passive oscillatory talar JM on the improvements in ankle DF ROM, dynamic postural control, and self-reported patient outcomes in individuals with CAI. A single dose of a Maitland Grade IV anterior-posterior talar glide JM did not result in statistically significant improvements in DF ROM, dynamic postural control, and self-reported patient outcomes, but some of the outcome measures resulted in large effect sizes, which indicates that JMs may provide potential clinical benefits for the improvement in DF ROM, dynamic postural control, and pain in patients with CAI. However, the 95% CI associated with theeffect sizes did cross zero, which is not surprising given the small sample size of the study.

Discussion of Main Outcome Measures

Star Excursion Balance Test

Altered dynamic postural control as measured with the SEBT has been observed in individuals with CAI.[59] In this current study, there were no statistically significant findings in the absolute changes in any of the directions of the SEBT when comparing theJM to the control group. However, a nearly significant group-difference was observed in the absolute change of the SEBT performance in the anterior direction

with a large effect size (d = 0.96), indicating that the JM technique may have a potential positive benefit for performance of the anterior direction of the SEBT. It has been suggested that JMs may be able to stimulate sensory receptors within and around the ankle joint, possibly influencing motor neuron pool availability and efferent motor output.[67,68] Grindstaff et al[69] observed an acute increase in spinal excitability of the soleus muscle following a distal tibiofibular joint manipulation in CAI patients. Joint mobilizations may stimulate sensory receptors and result in an increase in afferent activity along with the enhancement of neuromuscular function of the joint stabilizing muscles, ultimately leading to dynamic postural control improvement during the SEBT in the CAI group. However, we did not quantify muscle activation or spinal excitability of muscles surrounding the ankle joint in this study. Therefore, further investigation should examine the effect of JM on muscle activation or spinal excitability, as well as, the association between changes in dynamic postural control and muscle activation or spinal excitability following JM.

Hoch and McKeon[21] reported no difference in dynamic postural stability as measured with the SEBT between a JM and a control group. However, their study did notassess dynamic postural stability with the SEBT before providing the treatment, making it difficult to determine if the SEBT performance was improved following a single application of passive oscillatory JM. While we found large effect sizes for group- difference in the anterior SEBT performance, both groups had small effect sizes for pre- and post-intervention measurements of the SEBT in all directions, with 95% CIs that crossed zero, thereby limiting this clinical significance. Since difference in the absolute changes in the anterior normalized reach distance of the SEBT was approaching significance with a large effect size for group-difference in the absolute changes, we believe that if more participants were enrolled in the study, the power of the study wouldimprove, potentially resulting in a detectable statistically significant difference for the SEBT.

Conclusion

In conclusion, a single dose of a Maitland Grade IV anterior-posterior talar glide JM did not result in statistically significant improvements in DF ROM, dynamic postural control, and self-reported patient outcomes. However, some of the outcome measures had large effect sizes, indicating that JMs may provide potential clinical benefits for the improvement in DF ROM, dynamic postural control, and pain in patients with CAI. Future research should examine the effects of the JM technique on DF ROM, dynamic postural control and self-reported patient outcomes with a larger sample size.

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