ISSN: 03875547
Volume 45, Issue 01, February, 2022

Impact of Mulligan's Fibular Reposition Taping on Pain and Function in Chronic Lateral Ankle Instability Randomized Controlled Trial

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Keywords:
Fibular repositioning taping, Exercises, Pain, function, Chronic ankle instability.

ABSTRACT

This study aimed to explore the influence of fibular repositioning taping (FRT) on pain and function in individuals with lateral chronic ankle instability (CAI). This was a randomized clinical experiment in which 66 lateral CAI volunteers between the ages of 18 and 50 were selected randomly to one of three equivalent groups (I, II, and III). Group (I) received FRT, group (II) received FRT and exercises while group (III) received exercises only. Pain was evaluated using the Arabic version of the Numeric Pain Rating Scale, and function was evaluated using the Arabic version of the Foot and Ankle Ability Measure. within groups, when compared to pre-treatment, all three groups had significant improvements in pain and function after treatment among groups, Pain, and function post-mean values showed statistically significant differences, with group (II) outperformed groups (I) and (III), as well as group (III), outperformed group (I) FRT may be an effective treatment in CAI, yet exercise has shown better results than FRT in enhancing pain and function.

1. INTRODUCTION

Despite the enormous importance of the talocrural joint during weight-bearing activities, it is one of the most injured sites in the musculoskeletal system, with sprains representing approximately 75 % of its injuries [1]. Repeated incidences of talocrural joint ‘‘giving way," pain, edema, and reduced function were observed in around 32 % to 74 % of those who have had a lateral ankle sprain, a condition termed chronic ankle instability (CAI) [2]. CAI is a condition caused by mechanical and/or functional instability. Functional instability is a feeling of ankle joint instability owing to proprioceptive and neuromuscular deficiencies that result in greater postural sway, delayed peroneal reflexes, and a decrease in joint position sense, While mechanical instability, is a disturbance in joint mechanics induced by pathologic laxity, altered arthokinematics, and/or joint degenerative processes [3]. Because of their functional limitations, CAI patients have a worse health-related quality of life. They also have a greater fear of re-injury and activity avoidance [4].

The relevance of ankle complex positional faults, as a predisposing factor to CAI, following an acute ankle injury has recently gained attention. Mulligan was the first to postulate that some individuals have an anterior translation of the distal fibula on the tibia following acute lateral ankle sprains. He proposed that during the plantarflexion and inversion motion that caused the sprain, the anterior talofibular ligament (ATFL) pulls the distal fibula anteriorly. The ATFL is less tensioned when the fibula is more anteriorly positioned, allowing for greater ranges of inversion before constraint is applied and consequently contributing to CAI [5].

According to, patients who experienced CAI show anterior positional fault as a result of peroneal muscle tone alteration caused by abnormalities in the neuromuscular control system [6].

Mulligan's fibular repositioning taping (FRT) was introduced as a method of correcting an anterior positional fault and preserving fibular alignment [5]. FRT has been found to minimize the incidence of ankle joint sprain in a group of basketball players, enhance postural control in athletes with CAI [2], [5], and raise the soleus h-reflex in patients with CAI [7], [8].

Despite the widespread application of FRT clinically, its mechanics and effectiveness have no sufficient evidence in the literature, So the present study aimed to assess FRT's impact on pain and function in lateral CAI patients.

2. Materials and Methods

Sixty-six volunteers (33 males and 33 females) with CAI were enrolled to participate in this randomized controlled experiment. statistical software G*POWER (version 3.1.9.2; Franz Faul, Universitt Kiel, Germany) was used to calculate the appropriate sample size for this experiment, which suggested that N=66 was the acceptable sample size, that was achieved power equal to 0.8. On calculations we used α=0. 05, β=0.2 and an effect size of 0.5. Participants have been recruited from the Physical Therapy Outpatient Clinic, Cairo University, and Benha Fever Hospital. The Institutional Ethics Committee of the Faculty of Physical Therapy, Cairo University, Egypt approved the study (No: P.T.REC/012/002457). Prior to the beginning of testing, all participants read and signed a consent form.

Inclusion criteria incorporated patients diagnosed with CAI, their age range from 18 to 50 years, a background of at least one considerable lateral ankle sprain, with the first injury has occurred at least 1 year prior to study enrollment, patients were linked to inflammations (pain, swelling, etc), a minimum of one day of planned physical exercise was disrupted, the latest injury should be over 3 months before study enrollment and participants must report at least 2 incidents of ‘giving way’ throughout the previous 6 months before study enrollment [9].

Individuals were excluded if they had a history of dislocation, subluxation, or osteoarthritis in the ankle joint, history of lower limb surgery, fracture, Neurological deficits, allergy to rigid strapping tape, history of traumatic injury to the hip or knee, rheumatoid arthritis.

The sealed envelope method was used to randomly distribute volunteers into 3 groups. Group (I) included 22 subjects who were treated with fibular reposition taping (FRT). Group (II) included 22 subjects who were treated with fibular reposition taping (FRT) and exercises. Group (III) included 22 subjects who were treated with exercises only.

2.1 Evaluation

2.1.1 Arabic Numeric Pain Rating Scale (ANPRS)

The ANPRS incorporates an 11-point (from 0 to 10) ‘‘horizontal scale’’, the left 0 represents non-existent pain, while the right 10 represents the severest pain. The intermediate numbers are shown by rising numbers that increase in proportion to 10. Patients were asked to accurately express their pain on that scale [10].

2.1.2 Arabic Foot and Ankle Ability Measure (AFAAM)

The FAAM Measure is a 29-item questionnaire divided into two subscales: the first subscale is for Activities of Daily Living (ADL) of 21 items, while the second subscale for Sports contains 8 items. Every task is graded on a Likert scale of 5 points (4 to 0), ranging from "not difficult whatsoever" to "unable to accomplish." The sums of item scores for the ADL subscale range between 0 and 84, while those for the Sports subscale range from 0 to 32. [11].

The item score total was calculated by adding the patient's score on each item. The total number of items with a response was multiplied by four to calculate the highest potential score. Then the total item score was divided by the highest potential score. The resulting number was then multiplied by 100 to calculate the percentage. A higher score indicates a greater level of physical function [12].

2.2 Treatment

For six weeks, patients attended three supervised physiotherapy sessions each week, for a total of 18 sessions. Every one session extended about an hour and was guided by a physiotherapist with at least four years of clinical experience.

2.2.1 Fibular reposition taping

FRT was performed as previously described by Moiler and colleagues [13].

A 20-cm length of non-elastic tape (Mueller, Euro Tape is required for this procedure (2). At the lateral malleolus distal end, the first strip was attached. The tape was wrapped around the posterior lower leg obliquely, during which a painless posterolateral glide was delivered to the distal fibula, ending at the distal third of the tibia over malleoli. A second supporting strand was applied in the same way, with half overlap with the diameter of the first. The tape was applied with the patient lying supinely over the plinth [14].

2.2.2 Exercises program

1. Range-of-Motion Exercises

Patients who exhibited ankle joint limitation with no contraindications to mobilization underwent 2-minutes grade III joint mobilizations for 2 times, as recommended by [14]. Before each session, their ROM limitations were evaluated, and they were treated according to the clinical indication. Participants also performed sitting towel stretches and standing stretches while the knee extended and flexed in addition to joint mobilizations. A total of 5 to 10 minutes of ROM exercises were done per session.

2. Strength Exercises

A progressive resistance protocol including Thera-Band elastic bands, double-legged heel lifts, and double-legged forefoot lifts was used for strengthening. After completing three sets of ten double-legged forefoot and heel lifts, participants advanced to the single-legged forefoot and heel lifts. Strength training sessions lasted 10 to 15 minutes.

Subjects were advanced weekly in Thera-band strengthening according to the progressive resistance protocol established by [15]. Thera-Band, after being doubled, was suspended from a hook on the wall, then the looped end was attached to the participant's foot while sitting on the floor with their knees straight. Participants were asked to perform and concentrate on ankle plantar flexion, dorsiflexion, inversion, and eversion movements and not to move their knees or hips. To estimate the training resistance, the resting length of the doubled Thera-Band was multiplied by 70% [16].

2.3 Balance Exercises

The balance exercises protocol of [17] was used in this study because it has been shown to improve self-reported function in CAI patients. The categories of balance exercises were Eyes Open Static Balance: (Eyes Open Single leg balance, Eyes Open Single leg balance on a foam, Eyes Open Single leg balance on a balance board) and Eyes Closed Static Balance: (Eyes closed Single leg balance, Eyes closed Single leg balance on a foam, Eyes closed Single leg balance on a balance board). After completing 3 sets of 30 seconds each, patients were transferred to the advanced phase at the following session.

2.4 Statistical analysis

SPSS V25 (IBM Inc., Chicago, IL, USA) was used to conduct statistical analysis. This investigation was carried out as a prerequisite for the examination of difference's parametric computations. The Shapiro-Wilk test revealed that the ANPRS, ADL subscale, and sports subscale were normally distributed ($p > 0.05$). The variances of all variables were homogeneous, as calculated by Levene's ($p > 0.05$). According to the scatterplot, the dependent variables have a linear relationship. As a result, the test of 3x2 Mixed MANOVA had been performed to create a comparison between the investigated variables across three groups at various measurement times. The original alpha value was set at 0.05.

3. Results

3.1 Characteristics of the participants

The descriptive data of age, body mass index (BMI), and sex for the three groups are shown in Table 1. As indicated by the One Way Analysis of Variance (ANOVA), mean values of age and BMI across groups (I, II, III) did not show any significant differences (p>0.05). Chi-square revealed that there were no significant differences (p>0.05) in the sex distribution among groups (I, II, III).

Table (1): Descriptive statistics

	Group (I)	Group (II)	Group (III)	F-value	p-value	Level of significant
Age (years)	29.18 ± 4.38	28.68 ± 4.58	28.40 ± 4.74	0.162	0.851	N.S
BMI	22.4±2.3	22.8±2.5	23.1±2.4	0.231	0.733	N.S
Sex distribution N (%)						
Female	10 (45.45 %)	12 (54.55 %)	11 (50 %)	**X^2**	**p-value**	**Level of significant**
Male	12 (54.55 %)	10 (45.45 %)	11 (50 %)	0.364	0.834	N.S

*Significant at alpha level <0.05, BMI: body mass index

3.2 Testing the normal distribution of data

For all three groups, the ANPRS, ADL subscale, and sports subscale were normally distributed, as shown by the Shapiro-Wilk test ($p > 0.05$).

3.3 Testing of homogeneity

Levene's ($p > 0.05$) test found that all variables' variances were homogenous.

3.4 Correlation between dependent variables

The scatterplot revealed a linear correlation between the dependent variables, and Pearson correlation (|r| 0.9) revealed no evidence of multicollinearity.

3.5 MANOVA (3× 2 mixed design)

MANOVA (3x2 mixed design) revealed that the group tested (the first independent variable) had significant effects on ANPRS, ADL subscale, and sports subscale (F=4.03, P=0.001*). Furthermore, the measuring interval (the second independent variable) had a significant influence on ANPRS, ADL subscale, and sports subscale (F= 479.52, P=0.0001*). Additionally, the significant interaction between the group tested and the measuring interval demonstrates that the impact of the group tested on pain and function was affected by the measuring intervals (F=32.408, P=0.0001*).

3.5.1 Pain (ANPRS)

From table (2) it appears that there was a significant decline in pain after treatment compared to before treatment for all three groups (P-value =0.0001*). When considering the influence of the group tested on ANPRS, Multiple pairwise comparison tests (Post hoc tests) confirmed significant differences between (group I against II), (group I against III), and (group II against III), with this considerable improvement in favor of group (II) as opposed to groups (I) and (III), as well as in favor of group (III) as opposed to group (I).

Table 2. MANOVA for ANPRS at 2 measuring intervals across the 3 groups

ANPRS	Group (I) ($\bar{x} \pm$ SD)	Group (II) ($\bar{x} \pm$ SD)	Group (III) ($\bar{x} \pm$ SD)
Pre	7 ± 0.81	6.95 ± 0.89	6.77 ± 0.92
Post	5.45 ± 0.91	3.68 ± 1.08	4.77 ± 0.97
MD	1.55	3.27	2
% of change	22.14 %	47.05 %	29.54 %
Multiple pairwise comparisons of ANPRS pre-and post-treatment values across 3 groups			
Pre Vs. post	**Group (I)**	**Group (II)**	**Group (III)**
p-value	0.0001*	0.0001*	0.0001*
Multiple pairwise comparison tests (Post hoc tests) for the ANPRS across 3 groups at 2 measuring intervals			
	Group (I) X Group (II)	**Group (I) X Group (III)**	**Group (II) X Group (III)**

Pre	0.98	0.98	0.98
Post	0.001*	0.038	0.001*

x̄ is the group mean, SD is the standard deviation, *Significant at alpha level <0.05

3.5.2 ADL subscale

As presented in table 3, the ADL subscale increased significantly post-treatment in comparison to pre-treatment (P-value =0.0001*). Several pairwise comparisons (Post hoc tests) confirmed a significant difference between (group I against II), (group I against III), and (group II against III) and this significant improvement in favor of group (II) as opposed to group (I) and (group III). As well as in favor of group (III) as opposed to group (I).

Table 3. MANOVA for ADL subscale at 2 measuring intervals across 3 groups

ADL subscale	**Group (I) (x̄ ± SD)**	**Group (II) (x̄ ± SD)**	**Group (III) (x̄ ±SD)**
Pre	39.11±5.28	40.2 ±5.3	36.79±5.62
Post	42.03±5.32	53.65±6.42	47.07±5.21
MD	-2.92	-13.45	-10.28
% of change	7.46%	33.45%	27.94%
Multiple pairwise comparisons between pre and post-treatment values for ADL subscale across 3 groups			
Pre Vs. post	**Group (I)**	**Group (II)**	**Group (III)**
p-value	0.0001*	0.0001*	0.0001*
Multiple pairwise comparison tests (Post hoc tests) for the ADL subscale across 3 groups at 2 measuring intervals			
	Group (I) X Group (II)	**Group (I) X Group (II)**	**Group (II) X Group (III)**
Pre	0.98	0.48	0.123
Post	0.0001*	0.014*	0.001*

x̄ is the group mean, SD is the standard deviation, *Significant at alpha level <0.05

3.5.3 Sports subscale

According to Table 4, there was a significant rise in the Sports subscale pos-treatment as opposed to pre-treatment in the three tested groups (P-value =0.0001*). Several pairwise comparisons (Post hoc tests) confirmed a significant difference between (group I against II), (group I against III), and (group II against III) and this significant improvement in favor of group (II) as opposed to group (I) and (group III). As well as in favor of group (III) as opposed to group (I).

Table 4. MANOVA for Sports subscale at 2 measuring intervals across 3 groups.

Sports subscale	Group (I) (x̄ ±SD)	Group (II) (x̄ ± SD)	Group (III) (x̄ ± SD)
Pre	41.9 ± 6.14	40.19 ±6.04	40.62 ± 6.75
Post	47.29 ± 6.27	58.74 ± 8.18	52.46 ± 6.93
MD	-5.39	-18.55	-11.84
% of change	12.86 %	46.15 %	29.14 %
Multiple pairwise comparisons between pre and post-treatment values for Sports subscale across 3 groups			
Pre Vs. post	**Group I**	**Group II**	**Group III**
p-value	0.0001*	0.0001*	0.0001*
Multiple pairwise comparison tests (Post hoc tests) for the Sports subscale across 3 groups at 2 measuring intervals			
	Group (I) X Group (II)	**Group (I) X Group (III)**	**Group (II) X Group (III)**
Pre	0.98	0.98	0.98
Post	0.0001*	0.04	0.015*

4. Discussion

The objective of this trial was to evaluate the influence of FRT on pain and function in chronic lateral ankle instability.

By comparing pre and post-treatment data we found a significant improvement in pain as well as function in subjects who were treated with only FRT which may be attributed to correcting the positional fault of fibula by the effect of postero-lateral mobilization and taping, thus repositioning of fibula's inferior tibiofibular joint Mulligan [5], Hubbard [6]. This finding also could be explained by the improvement of skin proprioception, which increases the awareness of the foot position and motion direction, and therefore improve postural control after the application of FRT [7], [13], [18]. The increase in ankle dorsiflexion ROM that occurs after FRT could be a good explanation for the improvements encountered in our study [19- 22]. To allow appropriate movement at the ankle joint, adequate joint play at the distal tibiofibular joint is required as there is an upper and lateral glide of the distal fibula during ankle dorsiflexion, allowing for larger ankle joint mortise width [23].

[24], who demonstrated that FRT seems to be more valuable than traditional physiotherapy in alleviating pain and similarly efficient in restoring dynamic balance in patients with acute lateral ankle sprain, agreed with our findings. The findings were consistent with those of [25], who found that FRT improves weight-bearing on the injured ankle joint/s in addition to reducing pain. FRT increases functional performance in single-leg hopping, Figure-of-8 hop, and side hop, according to [26].

Contradicting our findings, [27] demonstrated that FRT had no effect on postural stability during both static and dynamic balance testing in participants with normal ankles when compared to placebo taping. This discrepancy with our findings might be attributed to sample variations, as they conducted their investigation on healthy subjects.

It is worthy to mention that [28] found that FRT both with and without tension did not lead to immediate alteration in soleus or peroneus longus spinal reflex excitability in CAI patients. Although FRT has been proved to be a beneficial treatment for CAI, the underlying mechanism may not include an immediate increase in soleus or peroneus longus spinal reflex excitability.

CAI patients have impaired proprioception [29], [30], diminished neuromuscular control [31], [32], lowered range of motion (ROM) [33], [34], and weaker ankle muscles [29], [31], [35]. Our rehabilitation program was designed to emphasize exercises that improve ankle ROM, muscles strength, proprioception, and neuromuscular control, and this may explain why the exercise groups (B and C) had better results than the FRT only group. This was supported by [14], [36]. Self-reported function improved after a comprehensive rehabilitation program, according to [37]. They observed that dorsiflexion ROM, balance, ankle muscular strength, and EMG amplitude measurements of the tibialis anterior, peroneus longus and brevis all improved.

The absence of long-term patient follow-up and measurement of neuromuscular control, which may be altered by FRT, are therefore limitations of this study.

5. Conclusions

FRT and exercises might be included in a physical therapy regimen for CAI patients, and exercises were more beneficial than FRT in reducing pain and increasing function.

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