JOURNAL ORTHOPAEDI AND TRAUMATOLOGY SURABAYA

JOINTS (Journal Orthopaedi and Traumatology Surabaya)
April 2023; 12(1): 10-15, DOI: 10.20473/joints.v12i1.2023.10-15
Received: 27 February 2023 / Revised: 12 April 2023
Accepted: 27 April 2023 / Published: 30 April 2023

Original Article

Medical Rehabilitation Impact Towards Dynamic Balance in Lateral Ankle Sprain Patients

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ABSTRACT

Background: Lateral ankle sprain (LAS) is one of the most prevalent and recurring injuries occurring during physical activities, especially sports. The resulting morbidity forces individuals to limit or change their physical activities. Medical rehabilitation can prevent recurrent injuries by restoring dynamic balance deficits. Previous studies have shown contradictory results. We investigated the effect of medical rehabilitation on dynamic balance in patients with LAS.
Methods: This was a numerical, analytical study with a prospective cohort design. Two groups, consisting of 13 LAS subjects each, were purposively chosen. Only the former participated in the three sessions of the rehabilitation program. The modified star excursion balance test was performed initially and three weeks later. Normalized composite scores were recorded in Microsoft Excel and statistically analyzed using SPSS 24 with a 5% significance level.
Results: LAS was commonly found in males (57.69%), with an average age of 20.62 ± 6.24 years old, on the dominant foot side (57.69%). Both groups were matched for age (p = 0.292), sex (p = 0.247), and dominant injured foot (p = 0.193). The rehabilitation group presented a greater increase in normalized composite score than the control (Δ = 3.10 ± 4.71 vs. 2.04 ± 7.05, p = 0.654).
Conclusion: Dynamic balance increased more in the rehabilitation group than in the control group, but the difference was insignificant. Medical rehabilitation should not be mandatory but optional for patients with LAS with limited resource access. Nevertheless, rehabilitation should be continued for other important aspects of treatment.

Keywords: Ankle; Sprain; Rehabilitation; Balance; Human and medicine

INTRODUCTION

Lower extremity sports or overuse injuries often happen in the ankle, with sprain being one of the commonest, specifically lateral ankle sprain (LAS).[1] It is observed that lateral had 0.93 incidences over a thousand athletes exposure (or simply two out of seven acute ankle sprain), while only 0.06-0.38 for the medial.[2] LAS is the tearing of the ligament on the lateral part of the ankle, whether partially or completely. The disease is classified into grade I to III based on the severity and prognosis. The lower the grade, the better the outcome.[3]

Once an individual experiences an ankle sprain, it tends to recur. A slight sprain injury of the ankle can microscopically attenuate the fine fiber of the ligament, which can optimally heal yet not fully and cause around 61% of recurring chance.[4] LAS majorly decrement the quality of life through a poor function of balance and movement.[5] Medical rehabilitation is one of the ways to prevent a recurrent ankle sprain.[6] A randomized control trial on 22 subjects with LAS that had progressed to chronic ankle instability showed that participants subjected to medical rehabilitation experienced a significant increase in ankle joint dynamic balance compared to subjects not subjected to medical rehabilitation.[7]

Ruvo et al. showed the potential of medical rehabilitation therapy that highly improved the dynamic balance and joint range of motion in ankle sprain individuals outweigh conventional therapy such as in the dorsal and plantar flexion (mean difference (95% confidence interval): 8.79 (6.81 - 10.77) and 8.85 (7.07 - 10.63)).[8] However, the method fails to 'heal' many ankle sprain patients because they often need to pay more attention to the injury and avoid hospitals or have poor compliance. Sixty-four percent of people with LAS reported not seeking medical attention and having more ankle injuries or sprains since then than the control ($p = 0.02$-0.04).[9] The International Ankle Consortium has even stressed important points on educating adherence and compliance among ankle sprain patients toward medical rehabilitation to prevent the risk of recurrent injuries.[10] Meanwhile, previous studies showed opposing results for the benefit of medical rehabilitation in preventing recurrent ankle sprain. A Canadian study of 503 ankle sprain patients showed no significant difference ($p = 0.710$) between the recovery of subjects subjected to medical rehabilitation and those who didn't want when assessed using the foot and ankle outcome score.[11]

Therefore, due to the different contradicting results, it is necessary to conduct further studies that might link the impact of medical rehabilitation in preventing recurrent ankle sprains through the measurement of dynamic balance changes before and after medical rehabilitation. This would also equip medical workers with adequate data to convince patients to seek medical rehabilitation to prevent recurrent ankle sprains.

MATERIAL AND METHODS

Study Design and Subject Enrollment

This study was an observational analytical study with a prospective cohort design. We purposively selected patients with lateral ankle sprain who were diagnosed or treated between January and April 2018 at AraPhysio (Physiotherapy Center at Pelita Harapan University), Pelita Harapan School in Lippo Karawaci, Islamic Village High School, and Medical Rehabilitation Outpatient Clinic of Mayapada Hospital in Modernland. The patients should be within 15-45 years old and, at most, 28 days after the incident, resulting in a lateral ankle sprain. Participants with the following conditions were excluded: (1) death, (2) presence or history of other foot trauma, (3) history of foot surgery, (4) presence or history of systemic inflammation, ulcers, fractures, systemic disease [e.g., diabetes or sepsis], and other injuries to the lower back and/or lower extremities. All recruited patients provided informed consent to participate in the study. By the Helsinki Declaration and Institutional Review Board, the current study received ethical approval (No. 053/K-LKJ/ETIK/II/2018) from the Ethics Committee of the Faculty of Medicine, Pelita Harapan University.

Data Collection and Measurement

We collected data from all the patients with LAS who met the inclusion criteria. The physician determined the presence of LAS through specific anamnesis, physical examination, and supporting examinations (e.g., deteriorating range of ankle motion, passive and active motor strength, anterior drawer test, subtalar tilt test, x-ray, etc.). Demographic variables (e.g., age and sex) and foot dominance were investigated using anamnesis and a government-verified identity card. Body weight (kg) and height (cm) were measured at baseline with a standardized scale and stadiometer and then computed manually to body mass index (BMI, kg/m^2). True leg length was measured using a measuring tape to compute the normalized composite score later. The modified star excursion balance test was used to assess dynamic balance reflected by the obtained normalized composite score. We measured the normalized composite score at baseline and three weeks later (i.e., after the medical rehabilitation sessions).

Modified Star Excursion Balance Test

The modified star excursion balance test (mSEBT) is a tool to measure dynamic balance in a lower extremity injury that can simultaneously assess the effectiveness of a treatment program such as medical rehabilitation.[12] This balance test is one of the commonest methods of evaluation used and had been validated by Attenborough et al. that scores less than 77.5% attained a 4.04 (1.00 - 16.35) times more risk in LAS than those with higher scores.[13] The test begins with the individual standing upright, hands on the hips, and one leg on the measured foot. Then straighten the other foot and move it away as far as he/she can to the anterior (ANT), posterolateral (PL), and posteromedial (PM) directions one at a time. Do this without putting any of the body weight on the after-mentioned feet. The examiner recorded the furthest point achieved in each direction as an average of three repetitions, which were then aggregated and converted to a normalized composite score of dynamic stability. We computed the reach distance and the normalized composite score using the following equations: reach distance = farthest point x (100 / correct leg length), while normalized composite score = (100 / correct leg length) x (average reach distance of ANT, PL, and PM).[12] Note that the proper leg length is the mean length from both the right and left anterior superior iliac spine to the distal tip of each medial malleolus, measured twice for each side, with the subject lying supine.

Measurements were discarded and repeated if any of the following occurred in the test: (1) shifting the body load to the lifted leg, (2) falling or losing balance, and (3) inability to return the lifted leg to the center after reaching the farthest point.[14] Performance measurement in each direction is required because each direction may have differing contributors. For instance, the anterior component performance depends mostly on the weight-bearing ankle dorsiflexion, while the posterolateral and posteromedial are by frontal stabilization components.[15,16]

Statistical Analysis

Data were filtered and tabulated using Microsoft Excel 365 (Microsoft, Redmond, WA, USA), and statisticians analyzed the data using SPSS version 24 (IBM Co., Armonk, NY, USA) with $p < 0.05$ for significance cutoff.17 Univariate data were expressed as mean ± standard deviation for numeric type and frequency (%) for categorical variables. The Shapiro–Wilk test was used to ascertain the normality of the data. Parametric data were then bivariate analyzed using the t-test (numeric vs. categorical) or Pearson correlation (numeric vs. numeric). In contrast, non-parametric data were analyzed using the Mann-Whitney (numeric vs. categorical) or Spearman correlation (numeric vs. numeric).

RESULTS

The study comprised of 26 patients with LAS with equal distribution in each group (medical rehabilitation vs. non-medical rehabilitation). There was no loss to follow-up or patient exclusion between baseline and the 3-weeks after measurement (100% participation rate). All LAS patients had been matched clinically and statistically ($p > 0.05$) in gender with a 1:1.36 female to male ratio, age of 20.62 ± 6.24 years old average, and dominance of the injured foot. The participant's body mass index (BMI) exerted a significantly moderate impact on the composite score change, with a 0.389 unit decrease for every increase in BMI. Table 1 presents the characteristics of the LAS participants.

Table 1. Clinical Characteristics of LAS Patients and Normalized Composite Score Change

Variable	All Patients (n = 26)	Normalized Composite Score Change / r	p-value
Gender			0.247*
• Male	15 (57.69)	1.40 ± 6.39	
• Female	11 (42.31)	4.16 ± 4.99	
Age (years)	20.62 ± 6.24	-0.113	0.292**
Body Mass Index (kg/m^2)	22.12 ± 2.53	-0.389	0.025***
Injured Foot			0.193*
• Dominant Foot	15 (57.69)	3.88 ± 1.68	
• Non-Dominant Foot	11 (42.31)	0.79 ± 1.41	

Value presented as frequency (%), mean ± standard deviation, or as it is | r: coefficient correlation
*Independent T-test, **Spearman Correlation, ***Pearson Correlation

Table 2. Medical Rehabilitation and Normalized Composite Scores

Patient Group	All Patients (n=26)	Normalized Composite Score			p-value[a]*	p-value[b]**
		Baseline	3-weeks After	Change		
Overall	26 (100.0)	90.19 ± 9.91	92.76 ± 10.96	2.57 ± 5.90	0.036	
Case	13 (50.0)	89.01 ± 12.26	92.11 ± 12.18	3.10 ± 4.71	0.035	0.654
Control	13 (50.0)	91.37 ± 7.16	93.41 ± 10.05	2.04 ± 7.05	0.318	

The value presented as frequency (%), mean ± standard deviation, or as it is | [a] baseline vs. three weeks after, case vs. control in a normalized composite score change, *Paired T-test, **Independent T-test

Treatments of LAS are proven to restore dynamic balance, represented by the increased modified star excursion balance test normalized composite score in both groups from the baseline. The medical rehabilitation group observed a significant increase in the normalized composite score ($\Delta = 3.10 \pm 4.71$, $p = 0.035$). However, the amount was not significantly different from the increase observed in the control group ($p = 0.654$). Table 2 shows the full effects of medical rehabilitation.

DISCUSSION

Medical rehabilitation markedly increased or restored dynamic balance in patients with LAS, although the increase was not significantly different from the control. The normalized composite score of the mSEBT showed an increased average score of 3.1% from the baseline. Lieshout et al. ascertained that a minimum of 6.9% and 5.0% increase in composite score in the respective left and right foot are minimally required for a significant restoration of dynamic balance,[18] of which has yet to be reached currently. This insignificance could be due to the non-standardized rehabilitation program that may differ in each lateral ankle patient received from the health centers. Cain et al. found that medical rehabilitation with BAPS protocols successfully increments the composite score on the anteromedial side ($p = 0.032$), medial ($p = 0.013$), and posteromedial ($p = 0.002$).[7] On the other hand, the duration and frequency of the medical rehabilitation program do not correlate to the significance of dynamic balance since we found $p > 0.05$ for three rehab times in three weeks, while $p < 0.05$ was found on three rehab times in four weeks but $p = 0.710$ for six months rehab.[7,11] Overall, we also included all stages of LAS, while previous studies limit it to the first and second degrees.[7,11]

This study also analyzed other factors influencing dynamic balance restoration in patients with LAS, namely, body mass index (BMI). BMI had a moderate negative correlation with the composite score, with a one-unit increase in BMI resulting in a 0.389 decrease ($p = 0.025$). A recent meta-analysis on LAS showed that LAS had a higher BMI than the control group (mean difference 0.56 kg/m2 [0.14 - 0.98], $p = 0.009$; I2 = 0%, $p = 0.62$).[19] Those with multiple occurrences of LAS also had higher mass and BMI than individuals with only a single LAS incidence ($p = 0.001$ and $p = 0.002$).[20] Obesity and high BMI induced stronger stress in the body, including the ligaments. Individuals often land in an inverse ankle position in sports, which puts pressure on the lateral ligament and exacerbate microinjury, especially in obese or high-BMI people.[21] Hartley et al. established a cutoff of 30.2 kg/m2 as a baseline in high risk of LAS injury for sports players, with those above 30.2 kg/m2 having 3.25 (1.80 - 5.86) higher risk of LAS than those below.[22]

We attempted to bridge the non-pharmacological modality of medical rehabilitation to improve dynamic stability in patients with LAS. However, limitations persist, including the small sample size, varying BMI, non-categorization of LAS levels, and the design nature. Future novel or replicative studies should include a larger sample pool, randomized control trial design, and account for BMI and LAS levels.

CONCLUSION

The rehabilitation group experienced a greater increase in dynamic balance, as denoted by a higher normalized composite score. Insignificance compared to the control rule that medical rehabilitation shall not be enforced for those limited in access or resources; it should continue as it can be beneficial in other aspects.

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