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Brief Communication

Effects of the standard physiotherapy programme on pain and isokinetic ankle strength in individuals with grade I ankle sprain

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Abstract

Objectives: The isokinetic evaluation of the ankle joint is important in determining the effectiveness of the rehabilitation programme for the management of ankle sprains. This study aimed to determine the effects of physiotherapy programme on isokinetic variables in individuals with grade I ankle sprains.

Methods: Seven patients with acute grade 1 ankle sprain (15 days of ankle sprain) were recruited. They were provided with 7 days of protection, optimal loading, ice, compression, and elevation (POLICE) treatment, and the standard physiotherapy programme consisted of towel stretching and balancing exercises on one leg. Pain scale score was recorded daily during the physiotherapy programme. The isokinetic ankle strengths of the patient's injured and uninjured legs were compared before and after the physiotherapy programme. Isokinetic tests were conducted in painless range of motion for the injured leg.

Results: Pain was significantly reduced after the patients underwent the standard physiotherapy programme. No significant differences were observed in terms of the ankle peak torque, time to peak torque, and ankle plantar flexion-to-dorsiflexion ratio of the injured and uninjured legs. The injured leg showed significant improvement in terms of ankle eversion-to-inversion ratio (E:I) after 7 days of performing the standard physiotherapy programme.

Conclusion: Performing the standard physiotherapy programme for 1 week reduces pain and improves the ankle E:I in patients with grade 1 ankle sprain.

Keywords: Ankle; Exercise; Isokinetic strength; Physiotherapy

Introduction

Ankle sprain is usually caused by an inversion injury. That is, the foot rolls underneath the ankle or leg. Individuals who had ankle sprains will complain of pain on the outside of their ankle and various degrees of swelling and bleeding under the skin (i.e., bruising). Depending on the severity of the sprain, a person may or may not be able to put weight on the foot. The sustained injury significantly varies in terms of degree and severity, depending on the structures involved. Grade 1 ankle sprain is a mild sprain occurring when ankle ligaments are slightly stretched. The symptoms of grade 1 ankle sprain include bruise, soreness, and swelling. Ankle sprains are more common in the athlete population than in the normal population.[1]

Acute impact forces in contact sports or the everyday rigours of training and conditioning result in ankle joint injuries.[2] The effectiveness of rehabilitation programme after injury determines the success of future functions and athletic performance.[3] An understanding of the body's response to

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injury is important in designing a rehabilitation approach.[2] Ligament and soft tissue injuries result in biochemical changes similar to those observed after an injury.[4] The injury results in bleeding and damage to tissues, which causes pain.[4] Therefore, the goals of ankle injury rehabilitation include controlling the acute inflammatory process, regaining full ankle range of motion (ROM), increasing muscle strength and power, and improving proprioceptive abilities. These goals can be achieved through various physiotherapy treatments.[4]

Recurrent ankle sprains and chronic ankle instability (CAI) may be managed effectively by exercise therapy.[5] Protection, optimal loading, ice, compression, and elevation (POLICE) treatment is commonly applied within the first 48–72 h after spraining an ankle. Interventions, such as neuromuscular training and balance exercise, are effective in addressing muscle strength deficits.[6,7] Early functional rehabilitation of the ankle should include ROM exercises and isometric and isotonic strength-training exercises.[4] Verhagen et al. have concluded that a proprioceptive balance board programme is effective for the prevention of ankle sprain recurrences.[8] Strengthening of weakened muscles is essential for a rapid recovery, and it is a preventive measure against reinjury.[9] In the acute phase of ankle sprain, the focus should be on controlling inflammation, re-establishing full ROM, and gaining strength.[3]

The isokinetic evaluation of the ankle joint is important in determining the effectiveness of the rehabilitation programme in managing ankle sprains. Isokinetic strength testing offers significant clinical controls, such as the ability to isolate particular muscle groups, provide options for muscular contraction types and ROM, and accommodate resistance. ROM is another controlled aspect of testing or exercising. By controlling the ROM, tests and exercises can be performed in an area that is free of pain. Therefore, this study aimed to examine the effects of the physiotherapy programme on pain and isokinetic ankle strength in individuals with grade 1 ankle sprains.

Materials and Methods

Patients

All procedures were conducted at a local university hospital. Patients with grade 1 ankle sprain were voluntarily recruited from the emergency department of the hospital. The patients completed their physical check-up and ankle joint clinical examination, which included inspection, palpation, and testing of laxity and instability in the frontal and sagittal plane by an orthopaedic specialist at the emergency department. The participants aged between 18 and 50 years who only received POLICE treatment and painkillers (i.e., ibuprofen) provided by the hospital were included. However, those with grade 2 and 3 ankle sprains, recurrent ankle sprains, any lower limb fracture, and any other disorders that could influence isokinetic test were excluded.

Anthropometric parameters, such as height, weight, and body composition, were measured before the start of physiotherapy programme. A portable stadiometer (Seca 220, Germany) was used in this study to measure the height of the patients. Weight and body composition were measured using the Body Composition Analyzer (TANITA, model TBF-410, Japan). During the measurement, the patients were asked to take off all their footwear and to wear light clothing.

Standard physiotherapy programme

After the patients were discharged from the emergency department, they were provided with a standard instruction regarding POLICE and passive joint mobilization within 1 week of treatment. Passive joint mobilization includes stretching exercise with towels, which can be started after 72 h after the onset of pain, and one-leg balance exercise, which can be performed when patients who are pain free can ambulate on a levelled surface without using an assistive device. Patients should stretch for 15–30 s using a towel for 10–20 repetitions. For one-leg stance balance exercise, patients should maintain their balance for 20–30 s and repeat it for 10 repetitions. Both exercises should be performed for 3–4 times per day. These exercises are the standard home-based exercises provided by the physiotherapy department of the local university hospital.

Test procedure

The level of pain was evaluated using the 10-point Visual Analogue Scale (VAS). The scale is 10 cm long with 'no pain' at one end and 'the most pain imaginable' at the other end. The participants used a pen to mark the line and to match the level of the pain that he or she perceived. The pain scale was marked by the participants every day during the whole week of treatment. The distances marked along the line by the participant were calculated to the nearest millimetre with the higher numbers representing more pain and the lower numbers representing less pain.[10]

Ankle strength was measured according to a standard protocol using an isokinetic dynamometer (Multi-Joint System 3 Pro, Biodex Medical Systems, Shirleys, New York, the USA). A strict adherence to the guidelines of the Biodex isokinetic dynamometer operations manual was followed, which include positioning of the participant, calibration, correction for gravity, familiarisation, and verbal encouragement. Painless ROM for ankle plantar flexion, dorsiflexion, eversion, and inversion was evaluated. The ROM for each ankle motion was determined according to the pain level experienced by each patient.

The velocity of the movement was set at $120^\circ \cdot s^{-1}$, which was recommended for ankle sprain evaluation.[11,12] Two consecutive trials of eight repetitions for each tested motion were recorded. For ankle plantar flexion and dorsiflexion tests, the chair was rotated to 90° towards the dynamometer. The dynamometer was rotated to 90° opposite the front position of the chair and tilted to 0°. The back seat was tilted to 70°–85°. The Limb Support Pad (with T-Bar) was placed under the distal femur and secured with a strap.

For the ankle eversion and inversion tests, the dynamometer was rotated to 0° and was positioned in line with the limb support. The chair was rotated 90°, and the dynamometer was tilted to 60°–70°. The back seat was tilted to 70°. The dynamometer was raised to align to the axis of rotation of the ankle joint, which is the same as the plantar

flexion and dorsiflexion tests. The gravity of the limb was corrected before the test. Biomechanical data of the peak torque (PT), time to peak torque (TTPT), total work, and average power were recorded.

Statistical analysis

Data were expressed as means and standard deviation (±SD). The differences between post- and pre-test were calculated and expressed as percentages. Statistical analysis was conducted using the Statistical Package for the Social Sciences (SPSS) software version 22.0.

Results

The ankle strengths of the patients' injured and uninjured legs were compared. Seven patients (male = 4; female = 3) participated in the study voluntarily. They are 25.1 years old ±4.97, with 59.0 kg ± 12.11 body weight and 1.6 cm ± 0.05 height. Their body mass index is 21.8 kg/m^2 ± 3.97, with 15.3 kg ± 8.28 of fat mass and 22.2% ± 5.58 body fat percentage. The non-dominant legs of two patients were injured, whereas the dominant legs of the other patients were injured. All patients were medically examined via a standard procedure by an orthopaedic specialist and diagnosed with grade I lateral ankle sprain.

Prior to the standard physiotherapy programme, the pain perception measured using the VAS was 8.57 ± 0.79, and it significantly reduced (p value = 0.001) to 6.44 ± 0.79 after a week of performing the standard physiotherapy programme. Approximately 26.96% of change in the pain perception before and after the physiotherapy programme was observed. Results of the isokinetic ankle PT, time to PT, and PT ratio for dorsiflexion, plantar flexion, eversion, and inversion of the patients' injured and uninjured legs before and after a week of physiotherapy were compared (Tables 1–3).

Table 1: Comparison of the isokinetic peak torque of the ankle joint at 120°·s^{-1} in the patients' injured and uninjured legs (N = 7).

Isokinetic Ankle Peak Torque	Injured Leg	Uninjured Leg	P value (both legs)
Dorsiflexion (Nm)			
Pre-test	19.43 (9.73)	20.61 (10.30)	0.132
Post-test	17.22 (5.28)	20.04 (10.83)	0.454
% difference	−11.37	−2.77	
P value (across time)	0.548	0.850	
Plantarflexion (Nm)			
Pre-test	16.76 (13.80)	21.31 (13.41)	0.110
Post-test	17.95 (6.87)	21.73 (8.93)	0.368
% difference	1.55	1.97	
P value (across time)	0.852	0.978	
Eversion (Nm)			
Pre-test	9.06 (4.77)	10.97 (4.60)	0.225
Post-test	11.76 (4.82)	12.17 (1.82)	0.329
% difference	29.80	10.94	
P value (across time)	0.234	0.431	
Inversion (Nm)			
Pre-test	11.64 (6.45)	12.30 (2.03)	0.203
Post-test	11.13 (4.44)	12.47 (4.37)	0.452
% difference	−0.438 (31.16)	1.38 (115.3)	
P value (across time)	0.253	0.432	

Values were presented as mean (standard deviation).
Nm = Newton meter; % = percentage.

Discussion

The level of pain evaluated through daily monitoring of the VAS significantly differed before and after the physiotherapy programme, which indicates that there was a decrease in pain level. As reported by Bleakley and colleagues[13] patients who received rest, ice, compression, and elevation (RICE) and performed exercises had improved ankle function 1 week post-injury compared with those who received RICE but with delayed initiation of exercise for 1 week. A previous study has shown that exercise and mobilisation techniques can help restore ankle function, ROM, and strength.[7,14–19] Mattacola and Maureen[4] have recommended ROM exercise as well as isometric and isotonic strength trainings for the early rehabilitation of acute ankle sprains. Achilles tendon stretching using a towel was recommended for restoring ROM in early ankle sprain rehabilitation. The towel was pulled toward the body for 15–30 s in 10 repetitions 3–5 times per day. This procedure was similar to that of the present study.

Muscle and ligament strengths were assessed to evaluate the effectiveness of the rehabilitation programme. PT indicates the muscle's maximum strength capability. Our results showed no significant differences in terms of the isokinetic PT of the ankle joint for all movements in the sagittal (e.g., plantarflexion and dorsiflexion) and frontal (e.g., eversion and inversion) planes of both the injured and uninjured legs after physiotherapy. It showed that 7 days of rehabilitation programme was not sufficient to significantly improve the isokinetic PT of the ankle joint.

The PT of plantar flexion showed positive changes in percentage difference after treatment of both legs. However, dorsiflexion movement showed negative changes in both legs. Strength training helps in improving the muscle strength of the plantar flexor muscle by lengthening the muscle to resist the towel stretch. The towel stretch exercises were provided during early rehabilitation to help recover ROM in the sagittal plane of the ankle during walking, and the joint in the sagittal plane was more involved than the movement in the frontal plane. Therefore, the injured leg contributed to functional deficit by reducing the ROM of dorsiflexion.[20] Fox et al. have also shown that a deficit was observed in the PT of the plantar flexor muscles in participants with ankle functional instability.[21]

Positive changes in the percentage difference in PT for eversion movement were observed, contrary to inversion movement, which showed negative changes. The ankle was resistant to inversion movement after 7 days of treatment. This result showed that the lateral ligament became stiffer and more resistant to inversion movement after 7 days of treatment. Previous studies have shown that lateral ligament ankle sprain is one of the most common sports-related injuries observed by physiotherapists.[8,22] A lateral ankle sprain occurs when the foot rolls inwards, thereby over-stretching the lateral ligaments.

Table 2: Comparison of the isokinetic time to peak torque of the ankle joint at 120°·s^{-1} in the patients' injured and uninjured legs (N = 7).

Isokinetic Ankle Time to Peak Torque	Injured Leg	Uninjured Leg	P value (both legs)
Dorsiflexion (ms)			
Pre-test	210.7 (72.4)	268.89 (218.68)	0.271
Post-test	310.0 (239.2)	207.86 (101.87)	0.231
% difference	47.1	−22.70	
P value (across time)	0.259	0.352	
Plantarflexion (ms)			
Pre-test	250.3 (124.8)	255.16 (225.95)	0.257
Post-test	190.0 (85.9)	151.43 (56.77)	0.116
% difference	−24.1	−40.65	
P value (across time)	0.411	0.398	
Eversion (ms)			
Pre-test	236.0 (140.8)	239.0 (137.9)	0.658
Post-test	251.4 (112.5)	257.1 (109.6)	0.632
% difference	6.2	7.59	
P value (across time)	0.841	0.612	
Inversion (ms)			
Pre-test	381.0 (164.1)	369.3 (223.2)	0.801
Post-test	340.0 (155.9)	327.1 (166.9)	0.864
% difference	−10.8	−11.4	
P value (across time)	0.615	0.597	

Values were presented as mean (standard deviation).
ms = milliseconds; % = percentage.

As shown by Uh et al.,[23] a significant improvement was observed in terms of isokinetic PT measurement in healthy participants after 8 weeks of ankle strength training. However, in the current study, due to the limited training period of 7 days, some of the changes in the outcome measures were not significant. Thus, the muscles around the ankle may require more time in recovering their strength after a sprain.

Weakness of the invertor muscles is common in chronic ankle instability.[24] Ryan[24] has suggested that the invertor muscles weakness is a result of the selective inhibition of the invertors' ability to start moving in the direction of the initial injury. However, contrary to Willems et al.,[25] no relationship was observed between invertor muscle strength and ankle sprains between participants with CAI and the control group. Moreover, the participants with CAI may have less evertor strength in concentric and eccentric contractions than normal participants. Brent et al.[26] have observed a greater effect on eversion and inversion strengths during the post-test in the training group than in the control group. Both groups have a history of ankle injury, although the training group used the strength rubber exercise bands and the Multiaxial Ankle Exerciser three times per week for 6 weeks while the control group did not perform any rehabilitation programme. This result showed that exercise training helps in improving the muscle strength of an injured leg in terms of eversion and inversion movement.

Table 3: Comparison of the isokinetic ratios of the ankle joint at 120°·s^{-1} in the patients' injured and uninjured legs (N = 7).

Isokinetic Ratio	Injured Leg	Uninjured Leg	P value (across legs)
Plantarflexion-to-Dorsiflexion Ratio			
Pre-test	0.79 (0.35)	1.24 (0.84)	0.168
Post-test	1.08 (0.46)	1.16 (0.34)	0.498
% difference	36.02	−6.45	
P value (across time)	0.270	0.747	
Eversion-to-Inversion Ratio			
Pre-test	0.77 (0.246)	0.87 (0.094)	0.405
Post-test	1.08 (0.152)	0.99 (0.201)	0.201
% difference	39.80	13.69	
P value (across time)	0.043*	0.161	

Values were presented as mean (standard deviation).
% = percentage.
*significance at $p < 0.05$.

The uninjured leg showed an increase in PT for all ankle movements except during dorsiflexion movement. This situation might explain the crossover effect in which changes in strength in one limb also occur in the contralateral limb.[21] As stated by Uh et al.,[23] strength training in one limb resulted in increased PT in both trained and untrained ankles.

TTPT was an indicator of the functional ability to rapidly produce torque. Therefore, decreasing TTPT showed improvement in the ankle strength (its ability to generate torque at a faster rate). Similar to PT, results showed no significant difference between ankle TTPT for all muscle movements in sagittal and frontal planes of both the injured and uninjured legs after physiotherapy programme. At 120°·s^{-1} isokinetic velocity, the evertor muscles of the affected ankle of the patients with CAI showed a significantly slower acceleration time in the evertor muscles compared to that in the unaffected ankle and both ankles of the control group.[27] The authors have concluded that the pain on the ankle joint caused the delay in the acceleration time of the ankle evertor muscles.

Ratio was measured using the PT of the plantar flexion-to-dorsiflexion ratio (P:D) and PT of the eversion-to-inversion ratio (E:I). After the standard physiotherapy programme, no significant differences in P:D was observed. However, E:I significantly improved. The evertor muscles may play an important role in preventing ligament injuries.[26] The strength of the peroneus longus and brevis muscles provides support to the lateral ligaments.[28] In case of a sudden inversion movement of the ankle joint, the effectors of the reflex are formed by the evertor muscles to counteract the movement.[29] This result indicates that stretch towel exercises may effectively stabilise an unstable ankle.

Conclusion

Physiotherapies consisting of RICE treatment and strain exercise via towel stretch were important in reducing pain and improving the eversion-to-inversion ratio of grade 1 ankle sprain. There were trends of increasing PT and faster time to generate the PT of ankle plantar flexion, dorsiflexion, eversion, and inversion ankle movements. However, these results were not significant. Therefore, the current study provides valuable information regarding the efficiency of RICE treatment and towel stretch exercise within 7 days of acquiring grade 1 ankle sprains. The rehabilitation programmes provided are simple, and they could be performed

at home without the assistance of a physiotherapist. In addition, the duration of the programme is short, and it is cost-effective.

Recommendations

Further studies regarding the best rehabilitation programme must be conducted to improve the recovery process of grade 1 ankle sprains. More patient-related outcomes and functional tests should be included to enhance our understanding of the development of a better treatment for grade 1 ankle sprains.

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Conflict of interest

The authors have no conflict of interest to declare.

Ethical approval

Ethical approval was obtained from the Human Research Ethical Committee of USM (USM/JEPeM/12100373).

Authors' contributions

SS wrote the original protocol, secured funding, and wrote the final manuscript. NSMS was responsible for recruitment and treatment, data handling, and data analysis. MAU assisted in the treatment intervention during the trial, data analysis, and interpretation of results. All authors contributed to and approved the final version of this manuscript. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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