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ORIGINAL ARTICLE

Effects of Multimodal Intervention on Pain, Range of Motion and Trunk Endurance in Patients with Hamstring Strain Injury – RCT

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Author`s Contribution

[1-5] Substantial contributions to the conception or design of the work for the acquisition, analysis or interpretation of data for the work, [1-5] Drafting the work or reviewing it critically for important intellectual content, [1-5] Final approval of the version to be published, [1-5] Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Article Info.

Received: July 24, 2024
Acceptance: January 10, 2025

Conflict of Interest: None
Funding Sources: None

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Cite this article as: Saeed H, Akram S, Ahmad H, Javed A, Khatoon S, Effects of Multimodal Intervention on Pain, Range of Motion and Trunk Endurance in Patients with Hamstring Strain Injury. JRCRS.2025:13(1):3-9.
https://dx.doi.org/10.53389/JRCRS.2025130102

A B S T R A C T

Background: Hamstring strain injuries commonly affect athletes particularly those engaging in activities that involve frequent high velocity and quick changes in direction. Such injuries cause severe pain, limitation of motion, and reduction in trunk muscular endurance and thus require longer time to rehabilitation.

Objective: To determine the effects of multimodal intervention on pain, range of motion and trunk endurance in patients with hamstring strain injury.

Methodology: A randomized controlled trial (RCT) was conducted with 60 participants (aged 18-30) divided into two groups: a control group receiving conventional physical therapy (CPT) and an intervention group receiving a multimodal intervention over six weeks. Data was collected using visual analogue scale, goniometer and trunk endurance test. Data was analyzed using SPSS 25.

Results: Both groups showed significant improvements ($p < 0.001$). By the 6th week, Group B achieved superior outcomes, with knee flexion increasing from 90.08° to 127.31° ($p = 0.002$), hip extension rising from 4.28° to 10.17° ($p < 0.001$), pain levels decreasing from 9.06 to 4.67 ($p < 0.001$), and trunk endurance improving from 2.17 to 3.72 ($p = 0.045$). In comparison, Group A showed improvements in knee flexion (89.89° to 118.31°), hip extension (3.81° to 7.78°), pain (8.31 to 5.78), and trunk endurance (1.78 to 3.22), but with less significant differences.

Conclusion: Multimodal intervention significantly improves pain levels, ROM, and trunk endurance in patients with hamstring strain injury, offering a comprehensive approach to rehabilitation.

Keywords: Hamstring muscles, muscle stretching exercises, pain management, ROM

Introduction

The hamstring strains that may be exhibited by an athlete are numerous and varied in severity. The aforementioned conditions include damages to the hamstring muscle that are classified into hamstring strains, complete and partial proximal hamstring tendon avulsions, ischial apophyseal avulsions, proximal hamstring tendinopathy, and referred posterior thigh pain.[1] Among the various types of hamstring-related injuries, hamstring strains are the most commonly observed, leading to a significant amount of time lost for athletes participating in sports across all levels of competition. Acute hamstring strains frequently lead to a substantial duration of recovery and are accompanied by a prolonged period of heightened vulnerability to subsequent injuries. [2]

Hamstring muscle strains are widely recognized as the predominant injuries in various sports disciplines such as track and field (specifically sprinting), rugby, and soccer, constituting a significant proportion of approximately 12% to 17% of all reported injuries.[3] The majority of hamstring injuries primarily impact the lateral muscles, specifically the biceps femoris (BF), rather than the medial hamstring muscles. These injuries commonly occur during sprinting activities, where the biarticular nature of these muscles allows them to function simultaneously as hip extensors and knee flexors.[4] There are other earlier studies that demonstrate low prevalence of semitendinosus (ST) and semimembranosus (SM) muscles in comparison to BF. The fact that there is an increased burden at the myotendinous junction of the ipsilateral BF during the Late swing phase of running is another important element.[5]

Sports that involve activities such as sprinting, kicking, high-speed skilled movements, and extensive muscle lengthening-type maneuvers, such as football, soccer, rugby, track, and dancing, are associated with a heightened susceptibility to acute hamstring strains. Research has indicated that there is a higher prevalence of acute hamstring strains in field sports such as football, soccer, and hockey, compared to court sports like basketball and volleyball.[6] Various risk factors associated with hamstring strains have been identified, which can be classified into two distinct categories: There are two categories of factors that can influence hamstring injury risk: unmodifiable factors and modifiable factors [7]. Unmodifiable factors include age and previous hamstring injury. Whereas, modifiable factors include; reduced hamstring strength, muscle fatigue, restricted joint range of motion, poor biomechanics of running and neuromuscular control. Due to the fact that one cannot alter inherent risk factors, the center of attention is placed solely on extrinsic factors when attempting to guard against a potential hamstring strain.[8]

Multimodal means modalities or treatments that includes one or more methods for addressing a particular issue or to achieve a certain goal. These modes can also include a number of sensory channels, communication strategies and therapeutic approaches thus broadening the coverage and effectiveness of the intervention. It is for these reasons that there exist many advantages that are associated with the use of multimodal interventions.[9] First of all, it can be stated that comparing to interventions targeted at one modality, multimodal interventions have more potential that can be achieved. Therefore, intervention efforts have to be, flexible and, hence, an amalgam of concepts can be used in order to reduce the rate of relapses. Moreover, these solutions can be fine-tuned to be more effective to suit the need of a given person. The effectiveness of multimodal interventions can be of great worth in the prevention and treatment of the hamstring strain injuries. These interventions should be carried out in order to reduce pain, increase the flexibility and strengthen the hamstring muscles.[10]

Stretching is a widely employed practice in sports due to its impact on the contractile properties of muscles, as muscle length is recognized to influence these properties. When muscles are either shortened or lengthened, their ability to generate maximum tension may be compromised if their resting length has been modified.[11] In addition, stretching exercises are frequently suggested for the purpose of preventing injuries to the lower extremities. [12]Nevertheless, recent literature reviews have generated controversy regarding the efficacy of prophylactic stretching in injury prevention. Conservative treatment for a hamstring strain is usually successful, though the strain can reoccur. Inflammation may be controlled with resting the leg, ice, compression, and elevation as well as anti-inflammatory medication. Also, therapeutic stretching and strengthening exercises are routinely prescribed for hamstring strains.[13]

Trunk endurance refers to the capacity of the muscles in the trunk region to sustain a prolonged static contraction. Core stability is of utmost importance in various physical activities, including lifting, carrying, and sports. The maintenance of trunk endurance is also crucial in the prevention of low back pain.[14] Hamstring strains are frequently observed among athletes, particularly individuals engaged in sports characterized by activities such as sprinting, jumping, or abrupt alterations in movement trajectory.[15]

Based on the current body of research, there is a lack of sufficient data regarding the impact of multimodal intervention on variables such as pain, range of motion and trunk endurance in individuals diagnosed with hamstring strain injury. Therefore, this study determined the effects of multimodal intervention on pain, range of motion and trunk endurance in patients with hamstring strain injury.

Methodology

It was randomized clinical trial conducted on 60 participants divided into two groups: Control group receiving CPT and an Intervention group receiving a multimodal intervention over six weeks. The calculated sample size using Range of Motion score as an outcome measure is 36 after adding 20% drop out in each group. The study was ethically approved under the number REC-UOL-542-10-2023.

Athletes aged 18 to 30 years with a history of hamstring strain injuries in the past year were recruited based on predefined inclusion and exclusion criteria. Inclusion criteria required participants to have a diagnosis of Grade I or II hamstring strain injuries, while exclusion criteria ruled out individuals with other muscular pain, lower limb fractures, or a history of lumbopelvic surgery. Participants provided informed written consent prior to the study and were assured of their anonymity and right to withdraw at any stage.

After baseline clinical evaluations, participants were randomly assigned to Group A (control group) or Group B (intervention group) using the lottery method. Allocation assignments were sealed in opaque envelopes and unsealed only after baseline assessments. Group A received conventional physical therapy consisting of a 10-minute hot pack application followed by range of motion (ROM) and stretching exercises. Group B underwent a multi-model intervention protocol comprising 18 sessions, each lasting 45 minutes. These sessions included patient counseling, 10 minutes of transcutaneous electrical nerve stimulation (TENS), 10 minutes of ultrasound therapy, and 20 minutes of manual therapy focusing on Nordic hamstring strengthening, core stability exercises, bridging, pelvic tilting, and weight training.

Data collection involved pre-intervention, 3rd week, and 6th week evaluations. Visual Analogue Scale (VAS) evaluates the pain not only in aspects of its intensity but also in its character and its affective perception by an individual as a complex experience in the recent time while Numeric Pain Rating Scale assessed the pain in aspects of its intensity in current time. ROM was measured with a handheld goniometer, and trunk endurance was evaluated using standardized tests for trunk flexors, lateral musculature, and extensors.

The objective of this study was to determine the effects of multimodal intervention on pain, range of motion and trunk endurance in patients with hamstring strain injury. Data was entered and analyzed on SPSS version 25. Statistical significance was set at $p = 0.05$. Descriptive statistics were entered in Frequency tables, pie chart, bar chart was used to show summary of group measurement measure over time. Normality of data was assessed by Shapiro-Wilk-Test. Between group comparisons was done through Independent sample t test. Meanwhile, within group difference was analyzed through Repeated Measures ANOVA. P value equals to or less than 0.05 was considered significant.

Results

The analysis of a sample of 60 individuals shows an average age of 23.43 years, with ages ranging from 18 to 30 and a standard deviation of 3.72 years.

In Group A, all outcomes improved significantly over time ($p<0.001$). Knee flexion increased from 89.89° at baseline to 111.33° at the 3rd week and 118.31° at the 6th week. Hip flexion improved from 77.44° to 83.17° and 91.44°, while hip extension rose from 3.81° to 6.11° and 7.78°. Pain levels decreased from 8.31 at baseline to 6.33 at the 3rd week and 5.78 at the 6th week. Trunk endurance also improved, increasing from 1.78 to 2.86 and 3.22. (Table 1)

Similarly in Group B , Knee flexion increased from 90.08° at baseline to 111.11° at the 3rd week and 127.31° at the 6th week. Hip flexion improved from 78.47° to 86.89° and 101.42°, while hip extension rose from 4.28° at baseline to 6.33° and 10.17°. Pain levels (VAS) decreased from 9.06 at baseline to 6.00 at the 3rd week and 4.67 at the 6th week, indicating reduced pain. Trunk endurance also improved, with mean scores rising from 2.17 to 2.83 and 3.72 over time. (Table 2)

The outcomes between Groups A and B for knee flexion, hip flexion, hip extension, pain levels (VAS), and trunk endurance across baseline, 3rd week, and 6th week evaluations. At baseline, no significant differences were observed for most outcomes ($p > 0.05$), except for hip flexion ($p = 0.027$, $np^2 = 0.068$). By the 6th week, significant differences were noted in knee flexion ($p = 0.002$, $np^2 = 0.126$) and hip extension at the 3rd week ($p < 0.001$, $np^2 = 0.196$). VAS showed significant differences at the 3rd ($p = 0.019$, $np^2 = 0.076$) and 6th weeks ($p < 0.001$, $np^2 = 0.765$), reflecting greater improvements in pain reduction in one group. For trunk endurance, significant differences emerged only at the 6th week ($p = 0.045$, $np^2 = 0.451$). (Table 3)

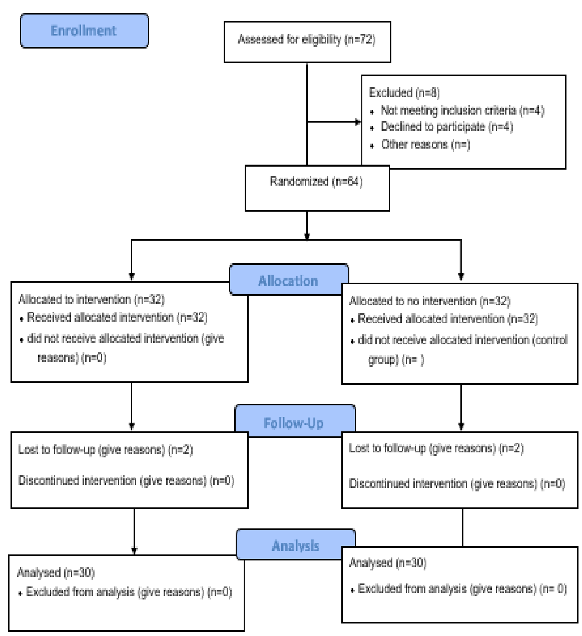

Figure 1: CONSORT Diagram

Table 1: Within Group Comparison among Group A of VAS, ROM and trunk endurance									
Outcomes	Evaluations	Mean	SD	Mean Difference	Std. Error	P value	95% Confidence Interval for Difference		Effect Size (np2)
							Lower Bound	Upper Bound	
Knee Flexion	Baseline	89.89	6.18	-21.444a	1.329	<0.001	-24.143	-18.746	0.466
	3rd week	111.33	5.27	-6.972b	1.411	<0.001	-9.837	-4.108	
	6th week	118.31	9.32	28.417c	1.826	<0.001	24.710	32.123	
Hip Flexion	Baseline	77.44	6.43	-5.722a	0.349	<0.001	-6.430	-5.014	0.367
	3rd week	83.17	5.35	-8.278b	1.531	<0.001	-11.386	-5.170	
	6th week	91.44	8.54	14.000c	1.699	<0.001	10.551	17.449	
Hip Extension	Baseline	3.81	1.37	-2.306a	0.111	<0.001	-2.532	-2.079	0.150
	3rd week	6.11	1.26	-1.667b	0.331	<0.001	-2.339	-0.995	
	6th week	7.78	2.15	3.972c	0.346	<0.001	3.270	4.675	
Visual analogue scale	Baseline	8.31	0.86	1.972a	0.213	<0.001	1.541	2.404	0.246
	3rd week	6.33	0.83	0.556b	0.122	<0.001	0.307	0.804	
	6th week	5.78	1.33	-2.528c	0.272	<0.001	-3.079	-1.976	
Trunk Endurance	Baseline	1.78	0.59	-1.083a	0.171	<0.001	-1.430	-0.737	0.321
	3rd week	2.86	0.68	-0.361b	0.114	0.003	-0.592	-0.130	
	6th week	3.22	0.64	1.444c	0.146	<0.001	1.148	1.741	

SD: Standard Deviation, a baseline to 3rd week, b 3rd week to 6th week, c 6th week to baseline,
Significance level: p<0.05*, p<0.01**, p<0.001***

Table 2: Within Group Comparison among Group B of VAS, ROM and trunk endurance									
Outcomes	Evaluations	Mean	SD	Mean Difference	Std. Error	P value	95% Confidence Interval for Difference		Effect Size (np2)
							Lower Bound	Upper Bound	
Knee Flexion	Baseline	90.08	5.92	-21.028a	1.492	<0.001	-24.056	-18.000	0.466
	3rd week	111.11	5.49	-16.194b	0.860	<0.001	-17.940	-14.449	
	6th week	127.31	1.86	37.222c	1.056	<0.001	35.078	39.367	
Hip Flexion	Baseline	78.47	5.22	-8.417a	0.506	<0.001	-9.444	-7.389	0.367
	3rd week	86.89	4.55	-14.528b	0.472	<0.001	-15.486	-13.569	
	6th week	101.42	4.10	22.944c	0.635	<0.001	21.656	24.233	
Hip Extension	Baseline	4.28	1.34	-2.056a	0.126	<0.001	-2.311	-1.800	0.150
	3rd week	6.33	1.31	-3.833b	0.247	<0.001	-4.335	-3.331	
	6th week	10.17	1.54	5.889c	0.321	<0.001	5.238	6.540	
Visual analogue scale	Baseline	9.06	0.67	3.056a	0.119	<0.001	2.814	3.297	0.246
	3rd week	6.00	0.76	1.333b	0.138	<0.001	1.053	1.614	
	6th week	4.67	0.83	-4.389c	0.092	<0.001	-4.575	-4.203	
Trunk Endurance	Baseline	2.17	0.78	-0.667a	0.218	0.004	-1.110	-0.224	0.321
	3rd week	2.83	0.70	-0.889b	0.182	<0.001	-1.258	-0.520	
	6th week	3.72	0.66	1.556c	0.162	<0.001	1.228	1.884	

SD: Standard Deviation, a baseline to 3rd week, b 3rd week to 6th week, c 6th week to baseline,
Significance level: p<0.05*, p<.01**, p<0.001***

Table 3: Between Group Comparison among groups of VAS and trunk endurance tests				
Outcomes	Evaluations	F(1,70)	P value	Effect Size (np2)
Knee Flexion	Baseline	0.037	0.847	0.001
	3rd week	0.554	0.459	0.008
	6th week	10.123	0.002	0.126
Hip Flexion	Baseline	5.129	0.027	0.068
	3rd week	2.180	0.144	0.030
	6th week	0.538	0.032	0.008

Hip Extension	**Baseline**	1.886	0.174	0.026
	3rd week	17.067	<0.001***	0.196
	6th week	3.182	0.079	0.043
Visual analogue scale	**Baseline**	0.019	0.891	<0.001
	3rd week	5.736	0.019	0.076
	6th week	0.029	<0.001***	0.765
Trunk Endurance	**Baseline**	1.245	0.268	0.017
	3rd week	0.019	0.892	<0.001***
	6th week	0.031	0.045	0.451

Significance level: p<0.05*, p<.01**, p<0.001***

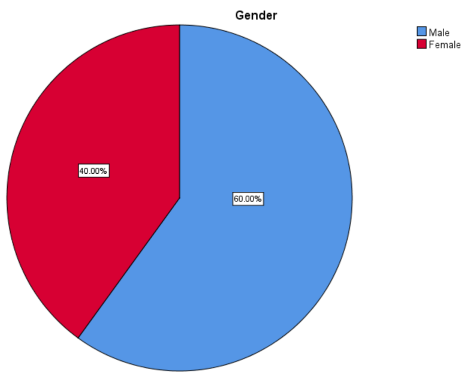

Figure 1: Pie Chart of Gender

Discussion

In comparison to previous studies to determine the effects of multimodal intervention on pain, range of motion and trunk endurance in patients with hamstring strain injury. The sample for the demographic analysis consists of 60 individuals, primarily reflecting a young population with ages ranging from 18 to 30 years. The gender distribution shows a higher proportion of males, with 60% of the sample being male and 40% female. The participants are evenly divided into two groups: Group A and Group B, with each group consisting of half the participants in the study. Multimodal interventions, which utilize a variety of therapeutic methods, have proven effective in alleviating pain from hamstring strain injuries (0.000).

Studies show that incorporating manual therapy to other treatment strategies including cryotherapy and electrotherapy significantly reduces the pain of the patients. These combined treatments work towards an assortment of goals that can eliminate the sensation of pain through molecules that may decrease inflammation or increase blood flow as well as interfering with nerve sensations the pain sends to the brain. Such an approach might therefore allow better pain control than many-modal interventions most of which only target one area of the pain. Increasing the ROM is a major axis in the management of hamstring strains.[16] The current study supports previous results that combining therapies such as manual therapy and electrotherapy improves pain and function in hamstring injuries. It does, however, highlight that a multi-modal strategy generates greater improvements in pain reduction and range of motion than single-modality treatments, stressing the need of targeting various recovery components at the same time.

The use of stretching techniques, PNF and mobilization techniques have been helpful in increasing the flexibility and ROM of the patients. These interventions are aimed at the muscular and neural aspects of the condition, by stretching the muscle fibers and reducing the time that the muscles spend immobilized [17]. Enhancing the ROM in addition helps in the fast rehabilitation process and also reduces re-injury chances since muscles that are flexible will not easily give in to the force exerted by physical tasks. It is an essential component of overall stiffness for individuals and especially the athletes and physically active individuals.[18]

Incorporating aerobic activities and core strengthening exercises, such planks and stability ball workouts, alters conventional hamstring therapy by considerably enhancing trunk endurance. By exercising the core, these exercises strengthen posture, minimize strain on the hamstrings, and play a critical role in preventing future injuries, making them an essential complement to injury recovery programs.[19] This suggests that when the routine includes activities to strengthen the trunk muscles, the client benefits from a more holistic treatment plan. Multimodal interventions can also provide psychological benefits by enhancing the patient's perceived level of hope.[20] It limits monotony in rehabilitation and therefore could increase compliance with rehabilitation programs due to the range of methods used. Marked changes in pain, mobility, and functional status have positive impacts on the patient's psychological well-being, eradicating anxiety or depression related to a particular injury.[21] According to the current study, patient outcomes and compliance are enhanced by a variety of rehabilitation techniques. Compared to Group A, Group B shown more improvements in trunk endurance, mobility, and pain reduction because to its multimodal approach. These improvements are consistent with findings in other research that emphasize the advantages of a variety of treatment approaches and probably helped to improve psychological well-being by lowering anxiety and depression associated with injury.

Another important aspect that should be considered when dealing with the analysis of rehabilitation outcomes is the process of evaluating the long-term results of the interventions. Unlike single interventions, multimodal interventions not only offer short-term fixes but also enhance long-term changes in pain, range of motion, and trunk endurance due to the treatment of the source of the injury. Studies show that patients who go through multimodal rehabilitation are more likely to avoid chronic pain or re-injury hence the value of adopting this approach for sustainable treatment.[22]

The results of the study have some important limitations that are important to consider while interpreting the findings. First, the analysis was carried on a limited study population: young athletes; therefore, the results may not be applicable to other populations such as older ones. Furthermore, the duration of the follow up was only six weeks; this may not capture long term changes that may have been brought about by the interventions. Moreover, there was some issue with data collection because mainly some of the players were unwilling to provide some of the required data this would compromise the accuracy of the study.

Because of limitations this study suggests that subsequent study should encourage the implementation of warm-ups and certain types of conditioning exercises in reduction of injuries. It is also suggested to ensure that psychological interventions and counseling are employed in rehabilitation to cope with the psychological aspects of injury and rehabilitation. In addition to this, the study recommends developing campaigns aimed at creating awareness of the need for the implementation of comprehensive Rehabilitation programs. They can aid in increasing the efficiency of the injury prevention and the rehabilitation, which will lead to better results on the athletes.

Conclusion

The study concluded that multimodal intervention is an effective treatment for pain reduction, increased in range of motion and trunk endurance in patients with hamstring strain injuries. This approach is more integrative and inclusive in the sense that it looks at several aspects of the injury and helps towards the management of the recovery process in the long run.

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