P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (RJIF): 5.38
IJPESH 2023; 10(1): 397-401

www.kheljournal.com
Received: 13-12-2022
Accepted: 10-01-2023

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Effects of core muscle strengthening on pain and dynamic balance among professional basketball players with ankle sprain

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DOI: https://doi.org/10.22271/kheljournal.2023.v10.i1f.2811

Abstract
Basketball is a contact sports that requires offense and defense. Ankle sprain in basketball is the most common injuries due to quick changes in direction with constant jumping and turns. The highest incidence of ankle sprain is 41.1% in basketball followed by other sports.
Objectives: To study the effectiveness of 6 weeks core muscle strengthening program in reducing the pain and improving dynamic balance among professional basketball players with ankle sprain.
Methodology: An experimental study was conducted among 20 professional basketball players with ankle sprain using Star Excursion Balance Test.20 participants were divided into 2 groups: experimental group (A) and control group (B). During 6-week time, the experimental group performed a core stability program with conventional physiotherapy, whereas the control group was dealt with only the conventional physiotherapy treatment.
Result: The result showed that there was significant difference in terms of pain and dynamic balance among the two groups.
Conclusion: The study concluded that core muscle strengthening can improve the dynamic balance and reduce the pain in basketball players with ankle sprain.

Keywords: Ankle sprain, star excursion balance test, core muscle strengthening

Introduction
Basketball is the popular internationally played sport, with basketball's requirement for repetitive jumping, abrupt changes in motion and need for explosiveness comes an increased risk of musculoskeletal injuries [1]. Basketball has greatest risk of injuries among all contact sports [1]. The highest incidence of ankle sprain is 41.1% in basketball followed by 9.3% in American football and 7.9% in soccer but ankle sprain is highly prevalent in basketball players [2]. The lateral ligament complex of the ankle joint is the most frequent location of the injury. Possible explanations of this finding are the presence of a strong deltoid ligament on the medial side and the fact that in the landing phase of the gait cycle the foot is slightly inverted, which may lead to susceptibility to an inversion sprain [3]. Ankle sprain may result in the player experiencing disability and residual symptoms, the most common being pain, sense of instability and weakness [4]. The clinical examination may show the presence of swelling, ecchymosis, point tenderness, pain full ROM or ligamentous laxity depending upon the severity of injury [5].
Dynamic balance refers to the capability of having suitable reactions regarding the motor system, in order to be able to cope up with the requirements needed for the quick alterations of position in the torso, while performing activities that add stress on the lower extremity. Operationally, the dynamic stability may be defined as the ability of the body to maintain position or intended trajectory after external or internal disturbances [7]. A stable erect body posture, or any specific joint, is controlled by the neuromuscular system in relation to the shift in the involved parts at the time of action including the core [8]. Pain may also affect dynamic balance in individuals with ankle sprain [9]. Deficiency in the control of the neuromuscular system of the body's trunk or "core" may affect the dynamic stability of the lower extremity [7]. For the purpose of rehabilitation, it is important to understand the severity of ankle sprain;

Grade 1- mild ligament stretching without joint instability; Grade 2- a partial rupture with mild joint instability; Grade 3- being complete rupture of the ligament complex with ankle instability [6].

One of the most important factors in maintaining postural stability and balance in the body is the function of the core muscles. There is close relationship between unbalance and lower body injuries [10]. The control of strength, balance, and movement in the center of body maximizes the connection between the upper and lower kinetic chains are the core muscles as it is the center of all kinematic chains. To describe core stability hip and trunk muscle strength, trunk muscle endurance, maintenance of a particular pelvic inclination or of vertebral alignment, and ligamentous laxity of the vertebral column all have been used [11]. The integration of core stabilization exercises into injury prevention programs, particularly for lower extremity, is demonstrating decreased injury rates. Core muscle function has been reported to influence structures from the low back to the ankle, to apply this concept to injury prevention [12].

Methodology

Study design: Experimental study.

Inclusion criteria

- Age between 17-25 years.
- Male basketball players
- Lateral ligament sprain in ankle
- Recurrent Ankle sprain

Exclusion criteria

- Surgery in the lower extremity
- Fractures in the lower extremity
- Female basketball players

Sample size: 20 participants

Sampling method: Convenient sampling 20 basketball players were assigned into 2 groups, Group A 'experimental group' and Group B 'control group'

Group A (N=10) received core muscle strengthening with conventional physiotherapy.

Group B (N=10) received conventional physiotherapy alone.

Study duration: 6 weeks

Treatment duration: 20-30 minutes, weekly three sessions.

Materials used

- Pen
- Pencil
- Measuring tape
- Marking tape
- Medicine ball

Procedure

Twenty male subjects participated in this study. Subjects were divided into two groups of 10 each. One group was assigned to experimental and second group was applied as the control group. The subjects were trained within three days of a week for total of six weeks.

Core muscle strenghening

This program consisted of three levels with some exercises at each level. The subjects began at exercise level one and proceeded to the next core strengthening program level according to the protocol for that week. The subjects performed the core stabilization training program three times per week on alternating days. They progressed to the next level of the core strengthening program according to the specific day of the week.

Table 1: Core muscle training intervention

Exercises	Week 1 and 2	Week 3 and 4	Week 5 and 6
Plank	Holding 3x20 seconds	Holding 3x30 seconds	Holding 3x45 seconds
Side plank right	Holding 3x20 seconds	Holding 3x30 seconds	Holding 3x45 seconds
Side plank left	Holding 3x20 seconds	Holding 3x30 seconds	Holding 3x45 seconds
Abdominal crunches	3x20 repetitions	3x30 repetitions	3x45 repetitions
Medicine ball Seated throw	3x20 repetitions	3x30 repetitions	3x45 repetitions
Dead bug	3x20 repetitions	3x30 repetitions	3x45 repetitions
Cross curl up	3x20 repetitions	3x30 repetitions	3x45 repetitions

The Group A and Group B will be assessed with visual analogue scale for pain and star excursion balance test for dynamic stability.

The following test to be taken at the start and at the end of the program.

Outcome measures

- **Star Excursion Balance Test:** The SEBTs are functional tests that incorporate a single-leg stance on one leg with maximum reach of the opposite leg. The SEBTs are performed with the subject standing at the center of a grid placed on the floor, with 8 lines extending at 45° increments from the center of the grid. The 8 lines positioned on the grid are labelled according to the direction of excursion relative to the stance leg: anterolateral (AL), anterior (A), anteromedial (AM), medial (M), posteromedial (PM), posterior (P), posterolateral (PL), and lateral (L). The grid was constructed in an athletic training facility using a protractor and 3-in (7.62-cm)-wide adhesive tape and was enclosed in a 182.9-cm by 182.9-cm square on the hard tile floor.
- A verbal and visual demonstration of the testing procedure was given to each subject by the examiner. Each subject performed 6 practice trials in each of the 8 directions for each leg to become familiar with the task, as recommended by Hertel *et al*. After the practice trials, subjects stretched the quadriceps, hamstrings, and triceps surae muscle groups before testing. To perform the SEBTs, the subject maintained a single-leg stance while reaching with the contralateral leg (reach leg) as far as possible along the appropriate vector. The subject was instructed to touch the furthest point on the line with the reach foot as lightly as possible in order to ensure that stability was achieved through adequate neuromuscular control of the stance leg (injured leg). The subject then returned to a bilateral stance while maintaining equilibrium. The examiner manually measured the

distance from the center of the grid to the touch point with a tape measure in centimetre's. Measurements were taken after each reach by the same examiner.

- Three reaches in each direction were recorded. Subjects were given 15 seconds of rest between reaches. The average of the 3 reaches for each leg in each of the 8 directions was calculated.

Data analysis

Statistical analysis of the data was done using SPSS 23.0. Descriptive statistics were calculated and summarized, which includes frequency, percentage, mean and standard deviation. Inferential statistics had been carried out in the study. Pre post comparison was done using paired t test. Between group comparison was performed by unpaired t test. Level of significance was set at 5%.

Results

In group A average age was 19.30±1.567 years and in group B was 19.5±0.707 years. Average weight in group A was 63.6 ±6.55 kg and in group B weight was 61.5±5.87 kg.

BMI of group A was 20.54±1.79 and that of group B was 20.07±1.96. Leg length in group A was 95.6±4.74 and group B was 95.4±3.13.

Table 2: Showing Age, Weight, BMI and Leg length

	Group	N	Mean	Std. Deviation
Age	Group A	10	19.3000	1.56702
	Group B	10	19.5000	.70711
Weight	Group A	10	63.6000	6.55235
	Group B	10	61.5000	5.87367
BMI	Group A	10	20.5400	1.79146
	Group B	10	20.0740	1.96762
Leg length	Group A	10	95.6000	4.74225
	Group B	10	95.4000	3.13404

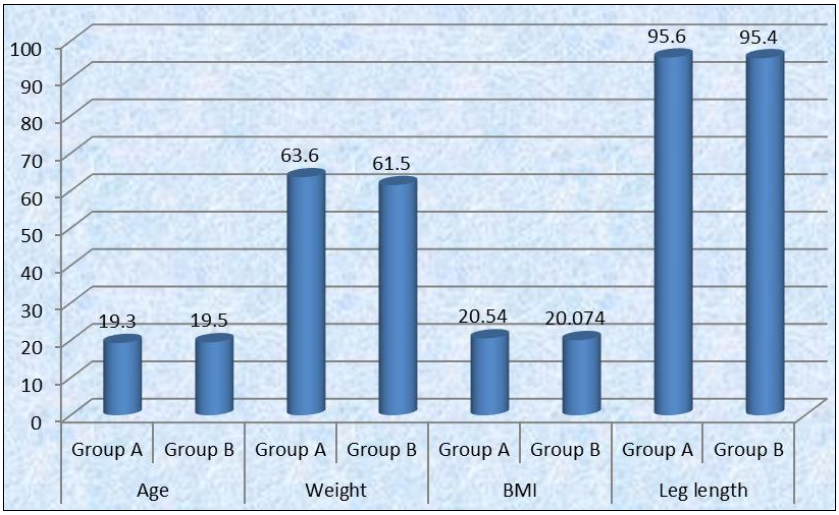

Fig 1: Representation of age, weight, BMI and leg length

Table 3: Pre post comparison in VAS

VAS		Mean	Std. Deviation	Average improvement	t value	p-value
Group A	Pre	8.4600	.85661	7.49	27.682	$p<0.001$
	Post	.9700	.51435			
Group B	Pre	8.6300	.53965	5.83	18.686	$p<0.001$
	Post	2.8000	.62183			

The comparison between pre and post VAS is shown in the above table. In group A the average pre VAS was 8.46±0.856 and post VAS was 0.97±0.514 with an average improvement of 7.49 and $p<0.001$. In group B the average pre VAS was 8.63±0.539 and post VAS was 2.8±0.621 with an average improvement of 5.83 and $p<0.001$. The analysis shows statistically significant improvement of VAS in group A and group B.

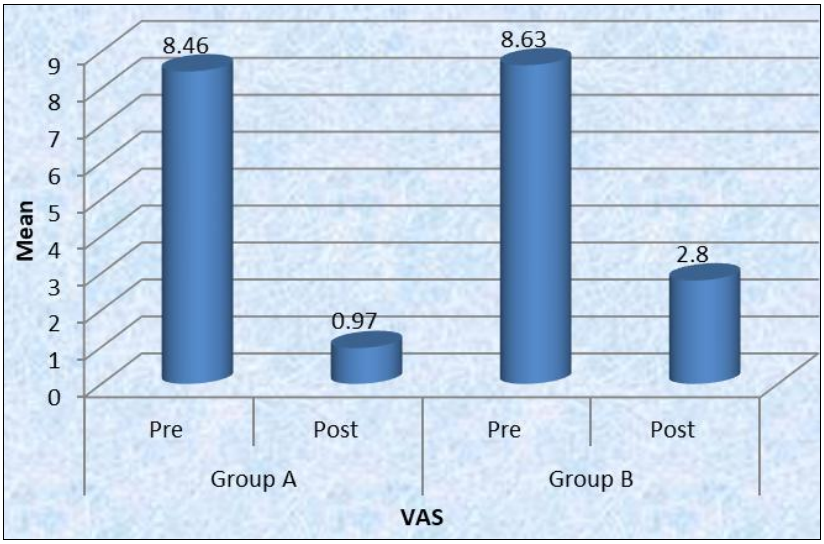

Fig 2: Representation of pre and post vas score

Table 4: Showing Comparison between the groups

	Group	N	Mean	Std. Deviation	t value	p-value
Anterior	Group A	10	11.07	2.480	6.183	$p<0.001$
	Group B	10	3.97	2.656		
Anterolateral	Group A	10	14.35	4.747	5.405	$p<0.001$
	Group B	10	4.75	3.005		
Lateral	Group A	10	12.19	6.063	3.760	$p<0.05$
	Group B	10	4.28	2.740		
Posterolateral	Group A	10	15.37	8.379	3.363	$p<0.05$
	Group B	10	5.68	3.572		
Posterior	Group A	10	14.39	5.573	5.032	$p<0.001$
	Group B	10	4.51	2.733		
Posteromedial	Group A	10	12.51	5.106	3.910	$p<0.05$
	Group B	10	5.46	2.544		
Medial	Group A	10	10.01	4.015	2.175	$p<0.05$
	Group B	10	6.44	3.294		
Anteromedial	Group A	10	13.54	5.483	4.116	$p<0.05$
	Group B	10	4.04	4.823		

The between group comparison of Anterior showed that in group A average Anterior was 11.07±2.480 and group B was 3.97±2.656 with of $p<0.001$. Between group comparison of Anterolateral showed in group A average Anterolateral was 14.35±4.747 and group B was 4.75±3.005 with $p<0.001$.

In Lateral the between group comparison showed that group A had average Lateral12.19±6.063 and group B had average Lateral of 4.28±2.74 with $p<0.05$. Between group comparison of Posterolateral showed that in group A average Posterolateral was 15.37±8.379 and group B was 5.68±2.733 with of $p<0.05$.

Between group comparison of Posterior showed in group A average Posterior was 14.39±5.573 and group B was 4.51±2.733 with $p<0.001$. In Posteromedial the between group comparison showed that group A had average Posteromedial 12.51±5.106 and group B had average Posteromedial of 5.46±2.544 with $p<0.05$. In Medial the between group comparison showed that group A had average Medial 10.01±4.015 and group B had average Medial of 6.44±3.294 with $p<0.05$.

Between group comparison of Anteromedial showed that in group A average Anteromedial was 13.54±5.483 and group B was 4.04±4.823 with of $p<0.05$.

Improvement in Anterior, Anterolateral, Lateral, Posterolateral, Posterior, Posteromedial, Medial and Anteromedial are significantly more in group A than in group B.

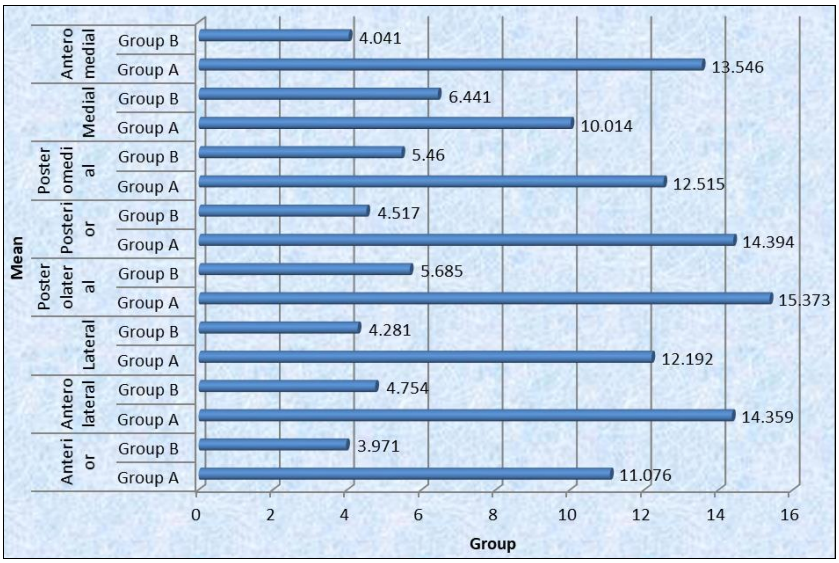

Fig 3: Showing average improvement

Discussion

This study was conducted to assess the effectiveness of core muscle strengthening on reducing pain and improving dynamic stability in male professional basketball players with ankle sprain. Even though the effectiveness of core muscle strengthening has been proved by many previous studies in various other lower extremity conditions, to the best of our knowledge, there is no study to analyze the effectiveness of core muscle strengthening for improving pain and dynamic balance among basketball players with ankle sprain patients.

In our study group A the average pre VAS was 8.46±0.856 and post VAS was 0.97±0.514 with an average improvement of 7.49 and $p<0.001$. In group B the average pre VAS was 8.63±0.539 and post VAS was 2.8±0.621 with an average improvement of 5.83 and $p<0.001$. This results indicates that there is significant difference in intensity of pain.

Players in Group A had more significant reach distance in Anterior, Anterolateral, Lateral Posterolateral, Posterior, Anteromedial, than in Group B. Posteromedial and medial both the groups had more significant reach distance ($p<0.001$). This shows that there is significant difference in dynamic balance between Group A and Group B.

Previous study was done on Volley ball players to find out the effectiveness of core stability exercises on dynamic balance. Determines the difference between the control and experimental group (core muscle strengthening). The significance level was smaller than 0.05. The results gathered with this study by comparison in pre-test and post-test between control and experimental groups showed that core stabilization exercise had significant effect (F=43.573, Sig=0.000) on dynamic balance in volleyball players [13].

The results of the previous study confirm that, core strength training is added to the physical fitness and basic technical training of college male basketball players, can make up for the single training effect of traditional training methods, it improves the overall quality of athletes' physical coordination and flexibility, and enhances the basic skills of basketball mobilization, such as dribbling speed and shooting [14].

This study has chosen dynamic balance instead of a direct measurement of core stabilization. Dynamic balance was influence by core exercise and was measured in this study via SEBT, which is proposed in the study, Herrington, Hatcher *et*

al, as a dynamic balance measurement tool. The findings of the current study are consonant with previous research, provide clinicians with a method of improving dynamic balance by improving core strength and applying the SEBT [15].

Conclusion

The study concluded that core muscle strengthening with conventional physiotherapy reduce the pain and increase the dynamic stability than only providing conventional physiotherapy in basketball players with ankle sprain. In order for the development to be sustainable, the core muscle strengthening program should be included in the training routines. More research is needed to determine the effects of a core stabilization program on dynamic balance. Future research should be including to core stability and biomechanical aspect of hip, knee, and ankle during the performance and landing from jumping.

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