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Isokinetic back training is more effective than core stabilization training on pain intensity and sports performances in football players with chronic low back pain

A randomized controlled trial

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Abstract

Background: Isokinetic training (IKT) and core stabilization training (CST) are commonly used for balance training in musculoskeletal conditions. The knowledge about the effective implementation of these training protocols on sports performances in university football players with chronic low back pain (LBP) is lacking.

Objective: To find and compare the effects of IKT and CST on sports performances in university football players with chronic LBP.

Design: Randomized, double-blinded controlled study.

Setting: University hospital.

Participants: Sixty LBP participants divided into isokinetic group (IKT; n=20), core stabilization group (CST; n=20), and the control group (n=20) and received respected exercises for 4 weeks.

Outcome measures: Clinical (pain intensity and player wellness) and sports performances (40 m sprint, 4 × 5 m sprint, submaximal shuttle running, counter movement jump, and squat jump) scores were measured at baseline, after 4 weeks, 8 weeks, and 3 months.

Results: Four weeks following training IKT group shows more significant changes in pain intensity and player wellness scores than CST and control groups ($P \leq .001$). Sports performance variables (40 m sprint, 4 × 5 m sprint, submaximal shuttle running, counter movement jump and squat jump) scores also show significant improvement in IKT group than the other 2 groups ($P \leq .001$).

Conclusion: This study suggests that training through IKT improves pain intensity and sports performances than CST in university football players with chronic LBP.

Abbreviations: CST = core stabilization training, IKT = isokinetic training, LBP = low back pain, VAS = visual analog scale.

Keywords: chronic low back pain, core stabilization training, football, isokinetic training, sports performance

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1. Introduction

Football has become one of the world's leading team events; according to Federation of International Football Association's survey, there are 265 million people actively participating in this game around the world. Increasing in the number of players could increase the number of sports injuries, which was noted particularly in the back region (47%).[1] Low back pain (LBP) is considered to be the major disability affecting this game and this injury is associated with trunk balance control.[2] Recent studies report that an injury to the soft tissues in the trunk during any sports affects the mechanism of trunk balance.[3] The decline in trunk balance control may be due to technological development, abnormal physical activity, pathological changes, and poor training in sports; and these factors lead to LBP in later stages.[4,5] Participation in football without proper training usually associated with risk of back injuries, which commonly affects the activities of daily living and good quality of life.[6] Therefore various injury prevention and post-injury rehabilitation programs have been formulated to prevent and treat such sports injuries.[7–9] Generally, sports physiotherapists and coaches are providing and adopting such training at on and off the field to the players.[10]

Ho et al observed that the trunk muscles of football players with chronic LBP were weaker than normal healthy subjects.[11] It is proved clinically that isokinetic training (IKT) has significant consistent results in mechanical LBP and found the positive correlation between trunk muscle imbalance and LBP dysfunction.[12] Usually in clinical studies the effectiveness of different exercise training protocols and fitness protocols in LBP were evaluated by measuring the core muscle strength.[13] The newly developed isokinetic trunk device is a tool which precisely measure the strength of the core muscles in LBP subjects. The device was also used as training –(IKT) and rehabilitating tool for improving the muscle strength in various musculoskeletal conditions.[14] Moreover operating this device requires a trained person, a suitable place and a particular appointment time in the sports set up. Hence there is lack of studies in the current sports field to analyze its effect on football players with chronic LBP.

Core stabilization training (CST) is a special type of training commonly used for core muscles of trunk in treating lower back problems. It uses different size of Swiss ball to train the core muscles. It offers the participants to control the center of gravity of the body with minimum base of support. Moreover, performing the exercises in Swiss ball is in upright position, which enhances the trunk muscle recruitment for spinal stabilization. Also the subjects found training through Swiss ball is highly inspired and added fun to the movements.[15,16] It is used widely due to the fact that the treatment session becomes more interesting which reduces the difficulty of rehabilitation. The real scientific physiological advantage of Swiss ball training is that this training permits the nervous system for neuroplastic changes and transferring into the muscular system for new motor learning.[17,18] In few studies there was a significant difference in the clinical outcomes among the subjects who had undergone conventional balance training and Swiss ball training in LBP subjects.[19,20]

Altogether, the knowledge about the effective implementation of IKT and CST and its effects on the sports performances of football players suffering from chronic LBP is lacking. Therefore, the aim of the study is to find and compare the effects of IKT and CST on sports performances in university football players with chronic LBP. Comprehensive understanding of the relation between sports training and sports performance promote this clinical condition in a positive way. Hence these types of sports trainings should able to modify the risk and reduce the impact of future consequences in football.

2. Materials and methods

2.1. Trial design

The study was a double-blinded randomized control study and the subjects were randomized and allocated equally according to computer random table method in 1:1:1 ratio in 3 groups. Sixty (N=60) subjects were randomized in the study and allocated to IKT (n=20), CST (n=20) and Control (n=20) groups. The study was approved by the Departmental Scientific Ethical Committee with reference number RHPT/020/001 and was conducted according to the ethical guidelines of the declaration of Helsinki 1964 and declaration of Tokyo, 1975. It was executed transparently and presented in accordance with CONSORT guidelines with Clinical Trial No: CTRI/2020/02/023342.

The study was executed in the Department of Physical Therapy and Health Rehabilitation, Prince Sattam Bin Abdul Aziz University, Al-Kharj, Saudi Arabia. Participants were recruited from the University Hospital and King Khalid hospital, Al-Kharj, Saudi Arabia. Sports therapist at the department evaluates the participants for participating in the study according to the eligibility criteria.

2.2. Patient involvement

In the initial phase, all the participants were instructed and explained about the research problems, study design, intervention procedures, outcome measures, study duration, harms, and benefits of the research through study information form. Subjects who read and consent to participate in the study involved in primary screening for final selection.

2.3. Participants

In order to take part in the study, the subjects have to agree to participate in the study and to sign the informed consent approved by the Ethical Committee. Inclusion criteria for selection of the subjects were as follows university male football players in the age group of 18 to 25 years, chronic (≥3 months) LBP and 4 to 8 pain intensity in visual analog scale (VAS) were included. Participants with severe musculoskeletal, neural, somatic, and psychiatric conditions, waiting for spine surgery, having alcohol or drug abuse, involving in other weight and balance training program were excluded from the study. Participants with other soft tissue injuries, fracture at the lower limbs and pelvic bone, deformities were also excluded from the study.

2.4. Interventions

The IKT, CST, and control group consist of 20 subjects in each group. The 4 weeks rehabilitation protocols for the 3 groups were accepted by the Ethical Committee. The rehabilitation protocol was carried out by an experienced and trained physiotherapist with 5 years' experience. This protocol specially laid stress on trunk muscle balance training and also they were instructed and advised to exercise at home as per instructions. We excluded 7 participants with excruciating pain (≥8 in VAS scale), 8 participants with

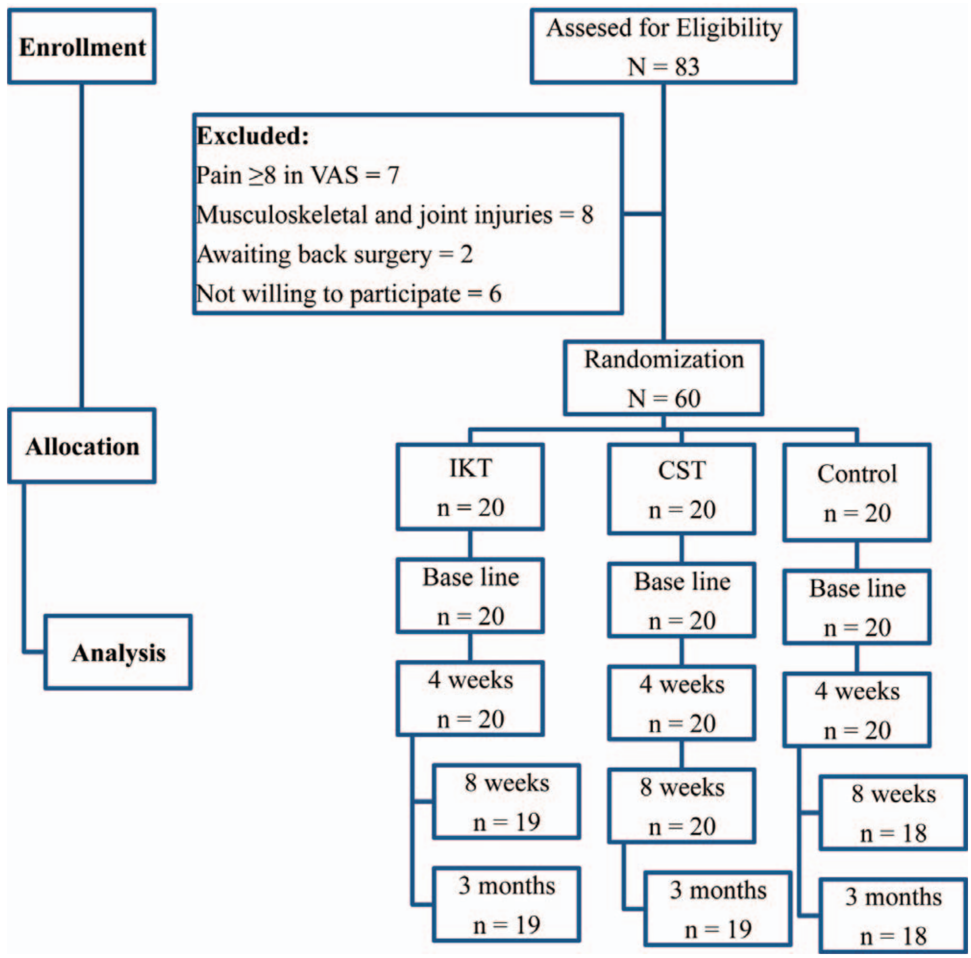

Figure 1. Flow chart showing the study details.

other musculoskeletal and joint injuries, 2 with awaiting surgery and 6 who were not willing to participate in the study (Fig. 1).

In IKT group before IKT, the subjects were asked to perform 5 minutes warm-up followed by slow stretching of back extensors and flexors. The subjects were asked to be in isokinetic dynamometer (Biodex Corporation, NY) in a vertical standing position. The knees were flexed slightly at 15 degrees, and the fixation straps were tied around the popliteus, thigh, pelvis, chest and scapula to prevent the tricky movements. Keep the trunk to maintain the range of motion of 10^0 of extension and 80^0 of flexion. The axis of the dynamometer was aligned with the intersection point of the mid-axillary line and the lumbosacral junction which is exactly 3.5 cm below the crest of iliac bone. The lever arm was customized according to the length of the subject's trunk and the resistance was given anterior and posterior to the trunk. The required modifications and procedures were done as per the user's manual to reduce the risk. The trunk was tested from -10^0 of extension to 80^0 of flexion 0 degree are considered as neutral.

The subjects were trained for familiarization in the exercise by showing model video clips and allowing them for practice attempts. Once they mastered in the training they were allowed to perform the exercise at an angular speed of 60, 90, and 120 degrees/s with 15 repetitions of 3 sets. Between each set 30 seconds rest and between each pace 60 seconds rest has been given. The training was given 5 days per week for 4 weeks. The subjects were monitored and instructed throughout their training by a supervisor. The outcome parameters were assessed by different examiner, who was experienced in handling isokinetic devices.[21]

In CST group, the participant received the balance training through Swiss ball (Fitness world, Italy) for core muscles. The size of the ball was decided according to the guidelines of Togu (height: ball size) (under 155 cm, 45 cm; 156–165 cm, 55 cm; 165–178 cm, 65 cm; over 178 cm, 75 cm). The exercises performed were Supine bridge, Sit-up, Arms-legs cross lifting, and Side bridge on the Swiss ball for 10 times per set for 3 sets for 5 times per week for 4 weeks. Participants were informed to maintain the position for 10 seconds, with a 3-second break between the repetitions.[22]

The control group focused on conventional balance training for core muscles. The training includes active isotonic and isometric exercise for abdominal muscles (internal oblique, external oblique, transverse abdominus, and rectus abdominus) deep abdominal muscles (psoas major, psoas minor, illiacus, and quadratus lumborum) and back muscles (erector spinae, transverses spinalis, inter spinalis, and inter transverse). They perform these exercise 10–15 reps/d for 5 d/wk for 4 weeks. Stretching should focus on each muscle group for 3 repetitions for 10 seconds per muscle group (hamstring, hip flexors, and lumbar extensors).

A home-based exercise protocol was prescribed to all the subjects to perform at home. All the subjects in 3 groups were spent 30 minutes for the training session and undergone hot pack therapy for 20 minutes and ultrasound with a frequency of 1 MHz and intensity of 1.5 W/cm^2 in continuous form for 5 minutes.[23]

2.5. Outcome variables

2.5.1. Pain intensity. The pain intensity was measured by VAS which consists of 10 cm horizontal line representing 1 end with "no pain at all" and the other end with "as bad as possible it could be." Each subject was asked to enter in the line as per his pain perception and the score is measured by the distance on the line. The reliability and validity of VAS in application of musculoskeletal conditions was good.[24]

2.5.2. Player wellness. The wellness of the player was measured by player wellness questionnaire in which the subject fills the 5 items (fatigue, sleep quality, muscle soreness, stress, and mood) in the questionnaire. The subject was asked to score on the 5 point Likert scale where 1 indicates very poor and 5 indicate very well. Therefore the additions of all 5 items provide the score between 5 and 25.[25]

2.6. Sprint performance

2.6.1. 40-m sprint performance. The subjects were instructed to do 10 minutes of warm up and asked to run for 40 meter with photocell timer (Microgate, Italy) placed at 40 meter. Three attempts have been made with 5 minutes of rest period, and the best result is considered for data analysis.

2.6.2. 4 × 5 m sprint (S 4 × 5 m). This test was done with 5 cones which were set at 5 meter apart and the photocell timer (Microgate, Italy) were placed at the beginning and end points. This test required frequent directional changes, where the subject started from the beginning point (cone 1) and run 5 meter to the point 1 (cone 2), where he made a 90^0 turn to left and ran for 5 meter to point 2 (cone 3) then take a second 90^0 turn to the right and ran for 5 meter to point 3 (cone 4). From point 3 took 180^0 turn to left and reach the last cone (cone 5).[26]

2.6.3. Submaximal shuttle running. The mechanical loading of the subjects was measured by submaximal shuttle running test. It was measured by MEMS device (Colibrys, Tokyo, Japan) and the device was worn in inter scapular region. Each subject was asked to do the shuttle run for 20 meter continuously for 5 minutes with average speed of 12 km per hour. Anterior-posterior, medio lateral and vertical measurements were recorded.[27]

2.7. Jump performance

2.7.1. Counter movement jump (CJ). The subjects were instructed to keep the hands placed on the hips and asked to jump to a self-selected depth. They were asked to jump as much as possible without hip or knee flexion during the flight phase.

2.7.2. Squat jump (SJ). The subjects were asked to maintain self-selected depth for 4 seconds count and asked to jump as much as possible with hip or knee flexion during the flight phase.

Each jump was performed for 4 times with 30 seconds rest. All the measurements (height, force, and velocity) were done with optical timing system (Quattro Jump, Switzerland) which is a reliable and valid tool to measure the jump height.[28]

2.8. Sample size

The subjects required for the study was N = 60 and in each group it was n = 20 which was obtained through a pilot study by assuming 80% power with 20% changes in pain intensity (VAS) with the standard deviation of 2 and significance level of 5%.

2.9. Randomization

An individual who is not involved in the data collection was used for randomization. The subjects enter in "IKT, CST, and Control" group following simple random table in 1:1:1 ratio in 3 groups. All the prospective subjects who fulfill the eligibility criteria were allowed to participate.

2.10. Blinding

Due to the design and settings of the study, it is not possible to blind the treating therapist involved in the study. The subject and the therapist who is assessing the outcomes at baseline, after 4 weeks, 8 weeks, and 3 months were blinded. Hence, the treating and assessing therapists were different persons and the assessing therapist remains blinded to the subject's treatment group assigned at all times. Subjects were instructed not to disclose the study procedures and treatment protocol with fellow subjects and the assessing therapist.

2.11. Statistical analysis

Subject demographic characteristics were measured to decide the study homogeneity using the Levene test. Outcome data were presented as mean and standard deviation and repeated measures of ANOVA was performed to determine significant difference within the groups. One way ANOVA test was used for comparison between the groups and the statistical significance level was set at $P < .05$. SPSS software (version 20.0) (SPSS Inc, Chicago, Illinois) was used for all statistical analyses.

3. Results

3.1. Participants

Out of 83 participants screened, 60 were selected and allocated equally (n = 20) into IKT, CST, and control group as per the selection criteria. The intention to treat analysis method was presumed in this study but 1 participant from IKT and CST group and 2 participants from control group were dropped out from the study. Descriptive demographic analysis of characters such as age, height, weight, and BMI were measured in all the 3 groups at baseline and presented as mean and standard deviation. The one way ANOVA test shows no significant difference ($P > 0.05$) between these characters in the groups which indicate study homogeneity. Moreover, the clinical parameters such as VO_2peak, heart rate, years of playing and duration of injury also measured to find the eligibility to participate in the exercise training program. These clinical parameters also show no significant difference ($P > 0.05$) between the groups at baseline (Table 1).

3.2. Pain intensity and player wellness

The baseline scores between IKT, CST, and control group of pain intensity (VAS) and player wellness have not shown any statistical difference ($P > .05$), which represents the homogenous

Table 1

Mean and standard deviation of demographic variables of isokinetic training, core stabilization training, and control group.

No	Variable	IKT	CST	Control	*P*-value
1	Age (yr)	21.11 ± 1.4	22.12 ± 1.3	21.38 ± 1.4	.061*
2	Height (m)	1.67 ± 0.14	1.66 ± 0.15	1.65 ± 0.13	.903*
3	Weight (kg)	66.8 ± 1.5	67.3 ± 1.5	66.4 ± 1.4	.160*
4	BMI (kg/m^2)	22.8 ± 1.3	23.2 ± 1.5	22.9 ± 1.5	.659*
5	VO_2peak (mL/kg/min)	38.2 ± 3.2	37.9 ± 3.4	37.9 ± 3.3	.946*
6	HR (beats/min)	167 ± 5.4	168 ± 5.5	167 ± 5.3	.796*
7	Years of playing (yr)	3.6 ± 1.2	3.5 ± 1.5	3.8 ± 1.3	.771*
8	Duration of Injury (m)	3.9 ± 0.7	4.2 ± 0.6	4.4 ± 0.7	.067*

IKT = isokinetic training, CST = core stabilization training.
* Nonsignificant.

population. Inter group analysis between IKT, CST, and control group at 4 weeks, 8 weeks, and 3 months follow up show significance difference ($P \leq .001$) after 4 weeks of training. Moreover the intra group analysis of IKT, CST, and control group show significance difference ($P \leq .001$) which means each group has considerable amount of improvement (Table 2). The Tukeys post hoc analysis and percentage of improvement between the groups reported that IKT group has more reduction in pain (Fig. 2) and improvement in player wellness than CST and control groups.

Table 2

Comparison of pain intensity, player wellness, sprint performance, and submaximal shuttle running of isokinetic training, core stabilization training, and Control group.

Sr.No	Variable		IKT	CST	Control	*P*-value
1	Pain intensity	Base line	7.2 ± 0.4	7.3 ± 0.3	7.4 ± 0.5	.308*
		4 wk	4.6 ± 0.3	3.6 ± 0.3	6.4 ± 0.5	.000†
		8 wk	2.5 ± 0.4	2.8 ± 0.5	5.2 ± 0.6	.000†
		3 mo	0.9 ± 0.3	1.8 ± 0.4	4.5 ± 0.3	.000†
		P-value	.000†	.000†	.000†	
2	Player wellness	Baseline	8.34 ± 1.3	8.52 ± 1.4	8.49 ± 1.5	.909*
		4 wk	15.13 ± 1.6	12.33 ± 1.5	10.22 ± 1.2	.000†
		8 wk	18.32 ± 1.5	18.05 ± 1.3	11.25 ± 1.4	.000†
		3 mo	20.56 ± 1.6	15.69 ± 1.5	12.28 ± 1.4	.000†
		P-value	.000†	.000†	.000†	
3	40 m sprint	Baseline	15.25 ± 0.3	15.35 ± 0.3	15.22 ± 0.4	.446*
		4 wk	11.25 ± 0.2	10.32 ± 0.3	13.28 ± 0.3	.000†
		8 wk	7.31 ± 0.4	6.35 ± 0.4	10.29 ± 0.4	.000†
		3 mo	4.46 ± 0.3	5.58 ± 0.2	9.15 ± 0.5	.000†
		P-value	.000†	.000†	.000†	
3	4 × 5 m Sprint (s)	Base line	23.21 ± 1.6	23.12 ± 1.5	23.15 ± 1.4	.981*
		4 wk	17.36 ± 1.2	18.13 ± 1.2	20.39 ± 1.2	.000†
		8 wk	10.32 ± 1.3	11.25 ± 1.2	16.18 ± 1.3	.000†
		3 mo	7.21 ± 0.6	9.34 ± 0.5	14.03 ± 0.6	.000†
		P-value	.000†	.000†	.000†	
4	Submaximal shuttle running A/P	Base line	8.88 ± 2.5	8.75 ± 2.5	8.52 ± 2.6	.901*
		4 wk	19.39 ± 1.8	17.23 ± 1.7	12.61 ± 1.5	.000†
		8 wk	26.56 ± 2.8	24.32 ± 2.4	16.54 ± 2.8	.000†
		3 mo	32.39 ± 1.8	29.37 ± 2.3	19.52 ± 2.6	.000†
		P-value	.000†	.000†	.000†	
	M/L	Base line	11.78 ± 3.2	11.53 ± 3.4	11.65 ± 3.3	.971*
		4 wk	18.23 ± 2.8	16.23 ± 2.8	13.91 ± 2.5	.000†
		8 wk	26.36 ± 3.4	22.42 ± 2.5	16.35 ± 2.2	.000†
		3 mo	33.69 ± 3.2	27.37 ± 3.3	17.82 ± 3.9	.000†
		P-value	.000†	.000†	.000†	
	Vertical	Base line	17.32 ± 3.8	17.83 ± 3.6	17.11 ± 3.2	.804*
		4 wk	29.29 ± 3.8	29.11 ± 3.3	23.51 ± 2.8	.000†
		8 wk	48.96 ± 2.8	35.62 ± 4.5	26.77 ± 2.2	.000†
		3 mo	60.45 ± 3.2	48.67 ± 3.3	30.82 ± 3.8	.000†
		P-value	.000†	.000†	.000†	

IKT = isokinetic training, CST = core stabilization training.
* Nonsignificant.
† Significant.

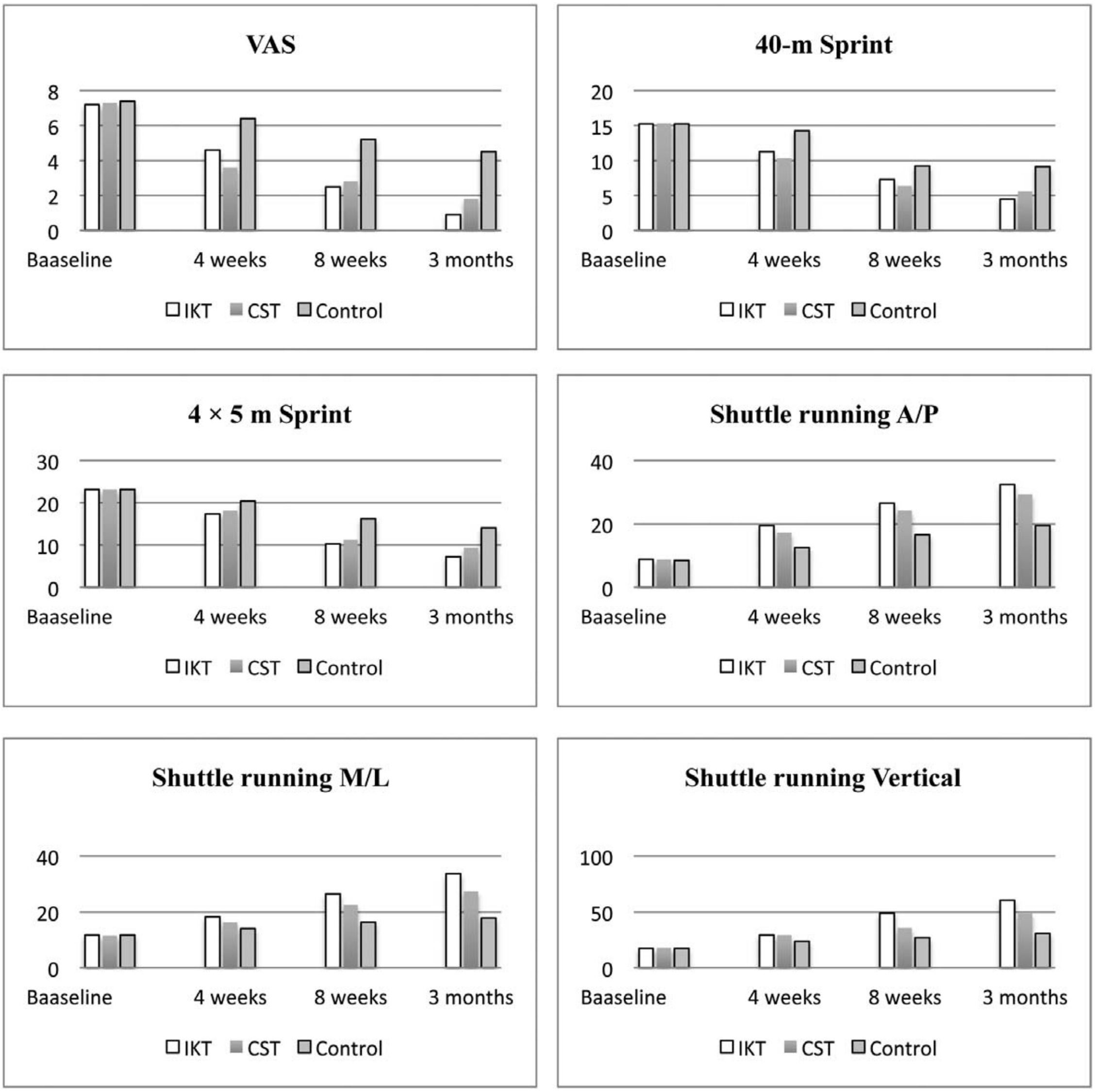

Figure 2. Mean values of pain intensity, 40 m sprint, 4 × 5 sprint, shuttle running A/P, M/L, and vertical scores in isokinetic training, core stabilization training, and control group.

3.3. 40 m sprint, 4 × 5 m sprint, and sub maximum shuttle running

The components of sports performance analysis such as 40 m sprint, 4 × 5 m sprint, and sub maximum shuttle running were measured before and after 4 weeks training in all the 3 groups. The follow up measurements like after 8 weeks and 3 months were also measured to know the short and intermediate effects of these training. There was no statistically significant difference ($P > .05$) between the 3 groups at baseline. Four weeks following different training protocols the participants were measured for the running performance which show statistically significant difference ($P \leq .001$) between the groups. The 8 weeks and 6 month follow-up measurements also show the difference ($P \leq .001$) between the groups which describe the running effect of IKT and CST training on sports performance (Table 2). Tukeys post hoc analysis and graphical representation shows more tendencies in improvement towards IKT group than CST group (Fig. 2).

3.4. Counter movement jump and squat jump

The jump performances such as counter movement jump and squat jump were measured at baseline, after training at 4 weeks and various intervals like 8 weeks and 3 months follow-up. There were no statistically significant differences ($P > .05$) between the groups in both the jump performances at the baseline evaluation. After 4 weeks training the analysis between the groups shows significant difference ($P \leq .001$) between the groups in CJ and SJ variables. It is also observed that there is statistically significant difference ($P \leq .001$) between IKT, CST, and control group in both the jumping variables at 8 weeks and 3 months follow up measurements (Table 3). However, the percentage of improvement between the groups at 3 months shows more tendencies in

Table 3

Comparison of counter movement jump and squat jump of isokinetic training, core stabilization training, and control group.

Sr.No	Variable		IKT	CST	Control	*P*-value
1	C jump height (cm)	Baseline	21.22±1.6	20.32±1.5	21.47±1.5	.052*
		4 wk	27.32±2.2	28.31±1.5	23.40±2.4	.000†
		8 wk	38.77±2.4	32.15±2.5	27.22±2.4	.000†
		3 mo	46.39±2.8	39.83±2.3	28.28±3.4	.000†
		P-value	.000†	.000†	.000†	
	Force (N)	Baseline	922.31±110	920.72±112	918.6±117	.994*
		4 wk	1056.1±122	1089.3±122	950.3±116	.001†
		8 wk	1232.6±118	1145.5±132	1045.2±112	.000†
		3 mo	1372.6±155	1211.7±180	1130.6±165	.000†
		P-value	.000†	.000†	.000†	
	Velocity (m.s^{-1})	Baseline	0.92±0.03	0.93±0.02	0.94±0.03	.073*
		4 wk	1.56±0.02	1.56±0.03	1.03±0.03	.000†
		8 wk	1.92±0.05	2.12±0.04	1.12±0.04	.002†
		3 mo	2.82±0.02	2.32±0.03	1.28±0.03	.000†
		P-value	.000†	.000†	.000†	
2	S jump height (cm)	Baseline	17.68±1.8	17.92±2.0	17.79±2.1	.928*
		4 wk	25.32±1.6	25.35±1.6	20.67±1.5	.193*
		8 wk	36.43±1.5	32.73±1.4	23.27±1.3	.002†
		3 mo	44.56±1.9	40.65±1.8	24.28±1.7	.000†
		P-value	.000†	.000†	.000†	
	Force (N)	Baseline	936.46±72	942.42±68	941.39±70	.959*
		4 wk	1188.42±86	1123.25±85	986.32±78	.000†
		8 wk	1245.57±85	1225.35±84	1076.3±81	.000†
		3 mo	1455.21±92	1239.29±93	1179.2±88	.000†
		P-value	.000†	.000†	.000†	
	Velocity (m.s^{-1})	Baseline	0.65±0.04	0.68±0.05	0.67±0.06	.171*
		4 wk	1.32±0.02	1.22±0.03	0.98±0.04	.000†
		8 wk	2.07±0.02	1.76±0.03	1.09±0.03	.002†
		3 mo	2.52±0.04	2.02±0.03	1.28±0.04	.000†
		P-value	.000†	.000†	.000†	

IKT = isokinetic training, CST = core stabilization training.
* Nonsignificant.
† Significant.

improvement towards IKT group than CST and control groups (Fig. 3).

4. Discussion

The main objective of this study is to find and compare the different effects of IKT and CST on sports performances in university football players with chronic LBP. In this study the pain intensity and player wellness improved significantly in IKT group when compared to CST and control group. Also in 40 m sprint, 4 × 5 m sprint and submaximal shuttle running, IKT group has shown more potential improvement and positive changes in the evaluation than the other 2 groups. Moreover, all the 2 groups showed substantial improvement in counter movement jump and squat jump after different types of training; IKT shows more positive tendencies towards improvement.

4.1. Isokinetic training

In this study the IKT was given at different angular velocities such as 60, 90, and 120 deg/s with high peak torque. Calmes et al observed that training at different angular velocities and high peak torque will improve the trunk muscle strength and flexors/extensors ratio in athletes.[29] These biomechanical changes may clinically reduce the pain and improve the wellness of the football players with chronic LBP. The current reports on these clinical changes were supported by Moussa et al and Zouita et al and also said that improving trunk muscle strength is the key role in preventing further injuries in back.[30,31]

We also found that little response in 40 m sprint, 4 × 5 m sprint and submaximal shuttle running after IKT. Training the trunk muscles is an important factor in improving the sports performance in different physical activity and sports. However, it is proved that IKT training in chronic LBP has positive impact on sprint performances and this is in accordance with Hibbs et al[32] Moreover, we also looked at the role of IKT on jump performance in football players with chronic LBP. Our study shows substantial improvement in CJ and SJ after IKT. The reports found considerable improvement in height, force, and velocity after IKT, these changes will be positively helpful in improving sports performance in LBP subjects which is in agreement with the study by Van Damme et al.[33] The available study on IKT suggests that it is balanced controlled exercise will further reduce the joint injury and improve the regeneration process which has positive correlation with the sports performance.[34]

4.2. Core stabilization training

This study provides the report that CST reduces the pain intensity by changes in the muscle recruitment process than the other 2 groups. It was noted that decreased activation of muscle response

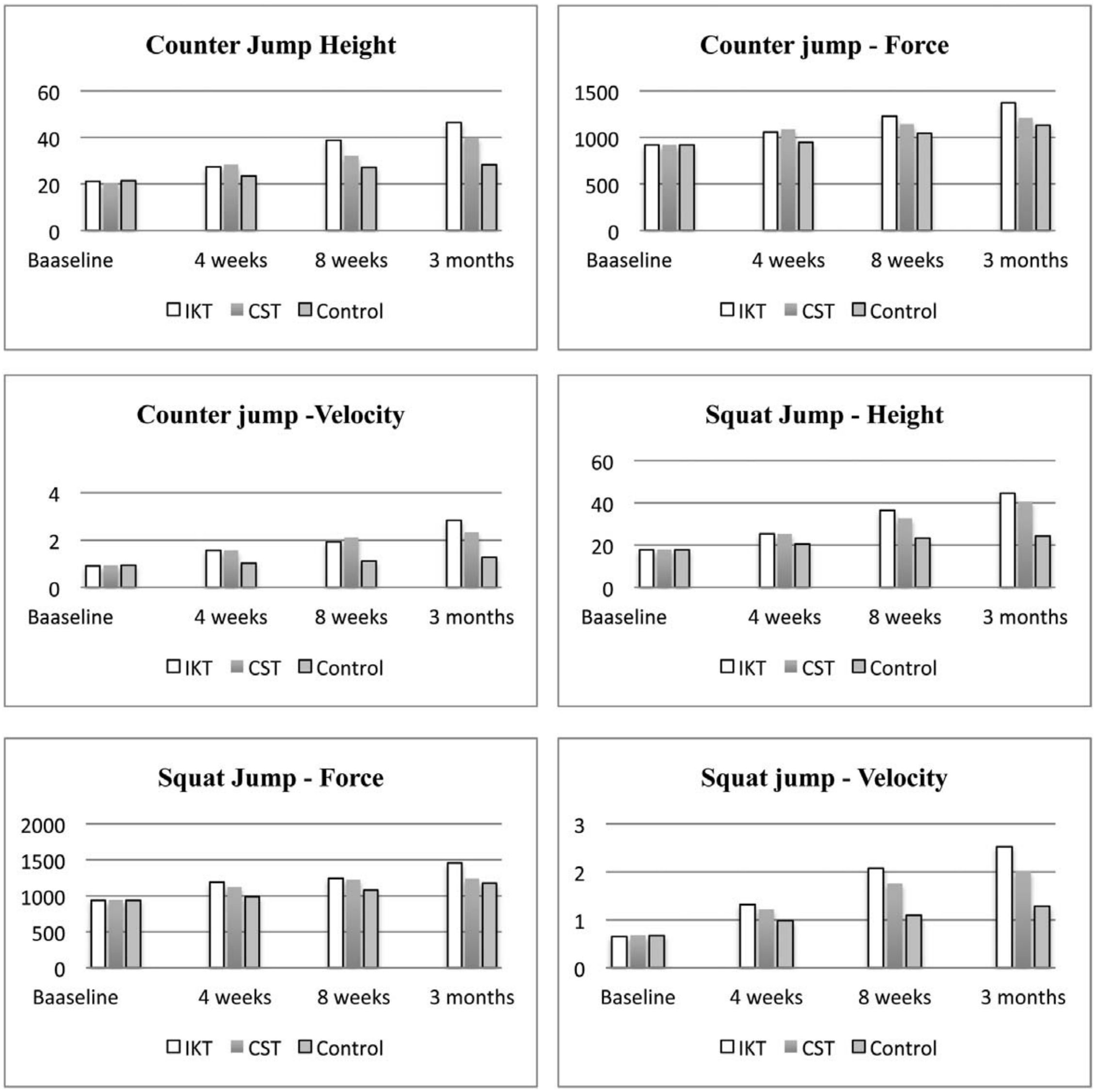

Figure 3. Mean values of counter jump (height, force, velocity) and squat jump (height, force, velocity) scores of isokinetic training, core stabilization training, and control group.

were present in chronic LBP subjects and CS training induces the muscle recruitment than the other 2 groups and result in alterations in muscle strength. The improvement in CST group is due to the fact that the ball provides the resistance to work but it was under the control of supervisor focusing on the recruitment of specific muscles. The mechanism behind little changes in pain intensity is by the comprehensive improvement in muscle strength, endurance, and flexibility of trunk muscles. It also increases the activity of the human sensory system and enhances the motor activity, which increases the strength and power of the targeted group of muscles which directly fasten the sports performance.[35] In the control group, the training was designed by increasing the challenge of the task through either reducing the base of support or sensory input which improves balance ability and the mechanism was yet not defined clearly.[36]

The greater strength of this study was sample homogeneity; hence the reports of this study can be generalized to the specific sports population. Also few limitations have been observed during the implementation of this study. First, this study did not measure and calculate the isokinetic parameters such as concentric, eccentric muscle strength of trunk flexors, and extensors. Secondly the association between the clinical and sports performance characters in chronic LBP after different training protocols has not been analyzed. Finally, follow up measurements were not taken in a long term basis, which could have been measured. Therefore, the future studies should involve analyzing the effects of isokinetic parameters in long term basis in chronic LBP subjects is recommended.

5. Conclusion

Overall, our study suggests that strength training through IKT protocol improves pain and sports performances than CST and other conventional training in university football players with chronic LBP. Including IKT program in rehabilitation program shows beneficial changes in pain intensity and sports performance in chronic LBP. Still, IKT is relatively presumed as a new training protocol for different sports injuries in different games.

Hence the future studies can be done to find the different effects of IKT on different sports injuries in different sports, which can be questioned and warranted.

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