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Singh[1], Baljinder; Kumar[2], Ashok; and Ranga[2], M.D.

Article Authorship & Affiliation Details

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Singh, Baljinder. PhD Research Scholar, Department of Sports Science, Punjabi University Patiala, Punjab, India. E-mail: bali007@rediffmail.com
Kumar, Ashok. Assistant Professor, Department of Sports Science, Punjabi University Patiala (Punjab) India
Email: akashokin@gmail.com
Ranga, M.D., Scientific Officer, Biomechanics Department, SAI NS NIS Patiala (Punjab) India

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Abstract

The present study was conducted on 30 male players (fifteen male hockey players; age: 16.80 ± 1.52 years & fifteen male football players; age: 16.13 ± 0.83 years) comprising of inmates of Sports Training Centre, scheme of Sports Authority of India and players training under the guidance of Punjab State coaches in Patiala (India). The experimental protocol developed by *Bosco et al., (1983) and Mcguigan et al., (2006)* were used to measure the vertical jump performance of male hockey and football players. Test of significance of the differences was applied and data was judged at 0.01 and 0.05 level of significance. The analysis of data shows that the male hockey players performed better in vertical jump test parameters like the squat jump flight time, squat jump height, counter movement jump height, counter movement flight time, Eccentric Utilization Ratio (EUR), Elasticity Index (EI) than the male football players. But male football players performed better in continuous vertical jump test (60sec) parameters like Peak Power (0-15sec), Peak Power (45-60sec) and Mean Power (0-60sec), as compared to male hockey players.

Introduction

Hockey and football are very dynamic team sports, requiring continuous alterations of intensity and kinetic actions and it is characterized by a great number of side movements, jumps, throws and body contacts all of which strictly depend on muscular strength. Coaches and trainers are greatly interested in developing training techniques designed to improve the explosive strength, power performance of the legs and vertical jump ability *(Blattner Stuart, 1978).* Several researchers have reported the anaerobic power & capacity of football players *(Verma et al, 1979; Kumar et al, 2014)* cricket players *(Kumar & Kathayat, 2014; Kumar et al, 2015)* and have compared vertical jump performance of male handball and basketball players *(Singh et al, 2013; Singh et al, 2014a; Singh et al, 2014b).* Numerous studies of young athletes indicated that specific training in track and field, gymnastics, swimming, soccer, basketball improve vertical jumping performance, explosive strength of upper and lower limbs. Soccer, *(Gorostiaga et al. 2002),* basketball *(Foley*

1988, Klizning, 1991), volleyball *(Mills et al. 2005)* and tennis training *(Huff 1972, Liemohn, 1983)* improve the explosive strength of lower limbs and consequently vertical jumping performance. During the last few years, performing plyometric exercises in general *(Wilt 1978)* and drop jumps *(Komi and Bosco 1978),* also called depth jumps *(Wilt 1978),* in particular, has become very popular in training. Strength is the ability to produce maximal force, which is considered a basic motor ability and contributes to high performance in most physical activities and sports for prevention of injury *(Coyle et al. 1981, Pangrazi 1999).* Previous studies have reported that the high performance in many sporting endeavours is characterized by the ability to display high amounts of muscular power. Power is the product of muscular force and velocity or as an instantaneous value during a given movement. The latter, often referred to as peak power (PP), is typically associated with explosive movements such as sprinting, jumping and may be an important variable associated with success in a given discipline. The measurement of Peak Power by strength and conditioning-coaches is an important consideration in the training process. Changes in peak power throughout the annual plan may be indicative of training status or adaptation to the workload and could be used to plan or adjust the training program based on the athlete's performance. The knowledge of mechanical power components of lower extremities of athletes of selected game disciplines can be of great interest for coaches and sport scientists to optimize talent selection in many sports disciplines. Therefore, the aim of the present study was to compare the vertical jump performance of male hockey and football players.

Materials and Methods

Thirty male players (fifteen male hockey players; age: 16.80 ± 1.52 years & fifteen male football players; age: 16.13 ± 0.83 years) briefed for the purpose of the study and the experimental protocol *(Bosco et al., 1983, Mcguigan et al., 2006)* comprising of inmates of Sports Training Centre, scheme of Sports Authority of India and players training under the guidance of Punjab State coaches in Patiala (India). All the risks involved were also explained to each player and voluntary consent was taken from them. Each volunteer was first subjected to physical examination that include measurements of corporal data like date of birth, age, training age, height, body mass and sports discipline. The participants performed an adaptation process previous to the vertical jump test so that error could be minimized. The vertical jump test measurement system consisted of a portable hand-held computer unit connected to a contact mat (Swift Performance, New South Wales, Australia). It has been previously reported that the system is reliable compared with a force platform *(Cronin et al., 2001).*

Vertical Jump Tests: Three jumps: Squat jump (SJ), Counter movement jump (CMJ) and Continuous vertical jump Test for 60 seconds (CVJT) were performed according to the experimental protocol *(Bosco et al., 1983, Mcguigan et al., 2006).*

Explosive strength and endurance variables: In this study, Eccentric Utilization Ratio (EUR) was calculated from vertical jump height (CMJ/SJ) or peak power (CMJ/SJ) by using *Sayers et al (1999)* peak power formula. Muscle Elasticity index was calculated from the

jump height reached in CMJ and SJ Jumps (CMJ – SJ *100 / SJ) *(Sayers et al., 1999).* The explosive strength and endurance variables were power peak (PP), mean power (MP) and fatigue index (FI). Concerning the CVJT (continuous vertical jump test), the PP was estimated by the mechanical power produced in the first 15 seconds of a 60-second work. The MP was estimated by the amount of work during a 60-second continuous effort. For PP and MP, the results were expressed in watts/kg (W/kg), according to the equation described by *Bosco et al. (1983).* The fatigue Index (FI) was calculated as the difference between the power peak (work produced in the first 15 seconds) and the mean power generated in the last 15 seconds of a continuous vertical jump work of 60 seconds relative to first 15 seconds peak power. The result was expressed in percentage (%).

Test procedure and data collection: The participants were told to perform a 15-minute routine warm-up before performing the tests through stretching, running, coordination exercises and consecutive jumps (two sets of five vertical jumps). Three squat jumps (SJ) and three counter movement jumps (CMJ) were performed in random order on a jump mat connected to an electronic timer without the aid of an arm swing; this was standardized by having participants hold their hands on their hips. Two minutes rest period between attempts was established. The SJ involved the subject flexing the knee to approximately 90^0 maintaining the position for 3 seconds, and then jumping on the command ‘‘go.’’ The CMJ was performed under the same conditions but involved flexion of the knee followed immediately by extension of the legs. Test was executed following the original protocol for both jumps *(Sayers, et al., 1999).* On the next day, again the participants performed a 15-minute routine warm-up before the tests through stretching, running, coordination exercises and consecutive jumps (two sets of five vertical jumps). The participants were told to perform the continuous vertical jump Test (CVJT) during a work performed at maximal effort, with no pauses between jumps for 60s. The subjects were told to keep chest in vertical position, with no excessive advance to avoid influence on the results; as well as to keep knees in extension during the flight, remaining with hands around waist. The participants were given stimulus to jump the highest as possible during the tests.

Statistical Analysis: Mean and standard deviation for all the attributes age, height, body mass and biomechanical transients related to vertical jump tests were calculated. Test of significance of the differences was applied and data was judged at 0.01 and 0.05 level of significance.

Results & Discussion

Statistically non-significant difference was observed between the various vertical jump performance parameters of male hockey and football players. *Francisco et al., (2010)* observed that the average squat jump height 15.8±4.2cm, flight time 357±44.4msec, countermovement jump height 16.9±4.8cm, flight time 369.0±49.9msec and elasticity index 7.1±3.2 for male table tennis players (age 11.32±1.82 years),

whereas in the present study the average value of squat jump height 28.80±4.26cm, flight time 490±40msec for male hockey players & squat jump height 26.93±5.61cm, flight time 470±50msec for male football players, countermovement jump height 31.73±4.22cm, flight time 510±30msec for male hockey players & countermovement jump height 30.00±5.79cm, flight time 490±50msec for male football players was observed. The Eccentric Utilization Ration (EUR) has been suggested as a useful indicator of power performance in athletes. *McGuigan et al., (2006)* observed the average value of Eccentric Utilization Ration (EUR) 1.03±0.20 for male soccer players, 1.00 ±0.17 for softball male players, 1.03±0.20 for football male players & 1.01±0.20 for rugby male players. In the present study the average Mean Power (0-60sec) recorded during the vertical jump test for hockey players was 15.35±2.57W/kg & for football players was 15.96±2.23W/kg whereas *Bosco et al. (1983)* found that average Mean Power (0-60sec) for school going boys (age 17.3±0.8 years) was 22.2±1.8W/kg. *Jefferson et al., (2007)* found the average Peak Power (0-15sec) 27.76±3.78W/kg, Mean Power (0-60sec) 19.56±2.59W/kg & fatigue index (%) (FI) 48.60±7.01 for male volleyball players (age 19.01±1.36 years). In another study by *Jefferson et al., (2006)* of the Intermittent vertical jump tests (IVJT) observed the average Peak Power (0-15sec) 24.68±2.70W/kg, Mean Power (0-60sec) 18.79±2.23W/kg & fatigue index (%) 57.50±9.51 for the male handball and basketball players (age of handball players 25.74±4.71years & basketball players 18.60±0.77years). In the present study the male football players performed better in continuous vertical jump test (60 sec) parameters like Peak Power (0-15sec), Peak Power (45-60sec) and Mean Power (0-60sec), as compared to male hockey players.

Table 1. Mean±SD of Age, height & body mass of male Hockey & Football players

Sport	Statistics	Age, yr	Ht, cm	Mass, kg
Hockey	Mean	16.80	177.87	64.27
(N=15)	S.D.	1.52	5.82	7.26
Football	Mean	16.13	174.40	56.13
(N=15)	S.D.	0.83	4.36	4.42

Table 2. Shows mean, S.D. and t-value of Vertical Jump performance variables of the three vertical jump tests of male Hockey & Football players

Sport	Stat	Squat Jump (SJ)		Counter Movement Jump (CMJ)				Continuous Vertical Jump test 60 seconds(CVJT) Mechanical Power (w/kg)			
		JH, cm	FT, Sec	JH, cm	Flight Time, Sec	EUR	EI	PP (0-15)	PP (45-60)	MP (0-60)	FI
Hockey	Mean	28.80	0.49	31.73	0.51	1.07	10.65	18.05	13.65	15.35	23.15
	SD	4.26	0.04	4.22	0.03	0.05	8.28	3.67	2.57	2.57	13.15
Football	Mean	26.93	0.47	30.00	0.49	1.09	11.88	20.03	13.52	15.96	31.16
	SD	5.61	0.05	5.79	0.05	0.05	6.75	4.37	2.63	2.23	13.87
	t	0.94	1.08	1.06	1.05	1.06	0.40	1.26	0.14	0.74	1.53

JH - Jump Height; FT-Flight Time; EUR-Eccentric Utilization Ratio; EI-Elasticity Index; PP- Peak Power; MP- Mean Power; FI - Fatigue Index

Conclusion: The analysis of data shows that the male hockey players performed better in vertical jump test parameters like the squat jump flight time, squat jump height, countermovement jump height, countermovement flight time, Eccentric Utilization Ratio (EUR), Elasticity Index (EI) than male football players. But male football players performed better in

continuous vertical jump test (60 sec) parameters like Peak Power (0-15sec), Peak Power (45-60sec) and Mean Power (0-60sec), as compared to male hockey players which may be due to the differnce in length of training and effect of specificity of training in particular sport.

Jumping test is possibly a useful tool in evaluating the mechanical power of the leg extensor muscles during explosive stretch-shortening type exercises in hockey and football players. The potential applications are to screen the changes in variables of mechanical power throughout the annual training with the purpose of monitoring the athlete's effectiveness of training and making the adjustments to the training program of individual player, depending on the test results.

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