

Electromyographical Bilateral Asymmetry of the lower limbs in Volleyball Players

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Abstract: Lower limb actions such as jumping, standing and squatting all require both legs to act equally to provide the most efficient movement, and limit the development of bilateral asymmetries which may lead to unilateral trauma and reduced performance. In this study ten male volleyball players with age ranged from eighteen to twenty four years of Lakshmbai National Institute of Physical Education, Gwalior. By Reviewing the literature and consultation with experts major muscles of lower limb i.e vastus lateralis, vastus medialis, Rectus femoris and gastrocnemius were selected. To investigate the bilateral asymmetries electromyography technique was used to determine the electrical activity during maximum voluntary isometric contraction (MVIC). Pro comp Infiniti of Bio Tec Thought Technology of eight channels was used as instrument to measure electrical activity. After a brief warm-up, electrode placement participants were tested thrice for maximum voluntary isometric contraction within the rest period in between of 3 minute to avoid any Fatigue. Descriptive statistics and t- test were applied to check the bilateral asymmetry at 0.05 level of significance. The findings of the study showed a significant difference in bilateral asymmetries of selected muscle group of lower limbs. Vastus lateralis showed highest electrical activity and gastrocnemius right shows lowest electrical activity during MVIC.

Keywords: Electromyography, bilateral asymmetry, Maximum contraction, Electrical activity, Isometric

1. Introduction

Only a small percentage of people has the natural ability to jump high. That is why it is important to train properly to improve your hops if you're not among that group. The quadriceps rest on the the front of the thighs and they have four components: the vastus medialis, vastus lateralis, rectus femoris and vastus intermedius.

During a jump, you perform hip flexion and knee extension, which both activate the quadriceps. The human quadriceps function primarily as knee extensors, providing large forces during pushing/pulling movements, and assisting in leg extension during running and jumping. In comparison with other primates, humans walk (and run) with the knee joint relatively extended (Winter et al. 1974; D'Août et al. 2002; Schmitt, 2003).

Moreover, during jumping, the knee extensor muscle stress reaches approximately 280 kN m^{-2} (Thorpe et al. 1998; bilateral countermovement jump) as the knee extensor moment reaches approximately 280 Nm (Bobbert et al. 1986). Therefore, human knee extensors must also be capable of producing relatively large muscle forces, often at high shortening speeds.

In volleyball players have to jump for block and spike number of times in each rally. At the men's national level of volleyball front court hitter have to jump 5 times with density of 32 sec and quick hitter have to jump 8 times with density 20 second (Papageorgiou, 2003). By keeping above said things in mind player have to develop his lower muscles of both legs in significant way but the variability in human physical activity patterns might also require different patterns of force generation, and thus different force-generating capacities in these muscles. This study is taken to check that the movement pattern of volleyball makes muscle stronger of any one limb than other or not.

2. Methodology

2.1 Participants and Variables

Ten male inter-university right handed volleyball players of the Lakshmbai National University of Physical Education, Gwalior were selected as subjects for the study by employing purposive sampling.

The age level of the subjects ranged from eighteen to twenty four years. Players had represented inter university level and had no lower extremity injuries or any bone or joint disparities within the past years. By reviewing the literature and consultation with experts, the research scholar carried out an intensive study and selected major muscles. The following muscles were selected for the study:

1. Vastus lateralis (Right and Left)
2. Vastus Medialis (Right and Left)
3. Rectus Femoris (Right and Left)
4. Gastrocnemius (Right and Left)

2.3 Procedure

The data for the selected muscles were obtained with the help of the instrument Bio Thought Technology of Eight Channels. The data were recorded in micro-volt (μV). The skin was prepared by shaving and cleansing to reduce impedance levels ($\leq 10 \text{ k}\Omega$). Biometrics SX230 active (Ag/AgCl) bipolar pre-amplified disc electrodes (Gain x 1000; Input impedance $>100 \text{ M}\Omega$; common mode rejection ratio $>96 \text{ dB}$; noise $1-2 \mu\text{V rms}$; bandwidth 20-450 Hz) with a 1 cm separation distance were adhered parallel with the muscle fibers. The data were collected of each selected muscles during maximum isometric voluntary contraction. Before the actual testing, the subjects were given a complete demonstration of each test and the purpose of the test were explained in details. After the demonstration and explanation, electrode were placed in a proper manner and

then subjects were allowed to practice trials in order to get familiarized with the test. On the day of testing each subjects were oriented to the testing protocol. The protocol was sequenced as mentioned below:

- 1) Warm- up
- 2) Electrode placement
- 3) Practice and familiarization
- 4) Exercise Protocol

1) Warm-up

Proper time was given to the subjects for general warm-up as well as for specific warm for particular group of muscles.

2) Electrode Placement

Site preparation for the electrode- interface included shaving of the area, followed by abrasion using an alcohol soaked pad and allow the alcohol to be vaporized so that skin will be dry before the electrodes will be placed and to remove the dead skin rubbing the site of electrode application vigorously. The skin preparation elicits a slight histochemical effect. Electrodes were placed according to the guidelines of SENIAM and reference electrodes were placed around the ankle.

a) Vastus Lateralis

Electrode was placed at 2/3 on the line from the anterior spina iliaca superior to the lateral side of the patella in the direction of muscle fiber.

b) Vastus Medialis-

Electrode was placed at 80% on the line between the anterior spina iliaca superior and the joint space in front of the anterior border of the medial ligament almost perpendicular to the line between anterior spina iliac and joint space.

c) Rectus Femoris

Electrode was placed at 50% on the line from the anterior spina iliaca superior to the superior part of the patella in the direction of muscle fiber.

d) Gastrocnemius

Electrodes was placed on the most prominent bulge of the muscle in the direction of the muscle.

3) Practice and familiarization

Sufficient practices were given for the better performance and the better recording of the data.

4) Exercise Protocol

For checking the bilateral asymmetry of selected muscle three times maximum voluntary contraction were performed by the subjects with 3 minutes rest to avoid any fatigue effects. The specific guidelines of SENIAM (1999) were used to test the maximum voluntary contraction of each individual muscles were as following.

a) Vastus lateralis

Extend the knee without rotating the thigh while applying pressure against the leg above the ankle in the direction of flexion.

b) Vastus medialis

Extend the knee without rotating the thigh while applying pressure against the leg above the ankle in the direction of flexion.

c) Rectus Femoris

Extend the knee without rotating the thigh while applying pressure against the leg above the ankle in the direction of flexion.

d) Gastrocnemius

Plantar flexion of the foot with emphasis on pulling the heel upward more than pushing the forefoot downward and asked to apply pressure against the forefoot as well as against the calcaneus.

3. Findings

Descriptive statistics and t- test were applied to compare the bilateral asymmetry of the selected group of lower limb muscles during maximum voluntary contraction. The level of significance was set at 0.05.

Table 1

S.No	Variables	Maximum	Mean	S.D	Mean Diff	t- test
1.	Vastus lateralis (Left)	593.67	510.165	53.89	97.98	5.274
2.	Vastus lateralis (Right)	451.27	412.185	23.38		
3.	Vastus Medialis (Left)	367.38	331.780	26.56	52.50	3.811
4.	Vastus Medialis (right)	315.74	279.274	34.53		
5.	Rectus Femoris (Left)	447.61	410.120	32.47	31.21	2.226
6.	Rectus Femoris (Right)	422.34	378.917	30.15		
7.	Gastrocnemius (Left)	421.73	382.291	29.43	46.74	3.492
.	Gastrocnemius (Right)	386.85	335.555	30.41		

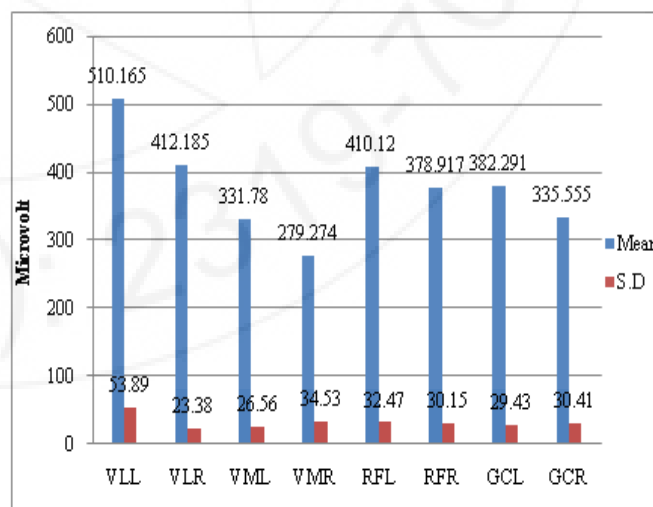


Figure 1: Graphical representation of mean and standard deviation of selected muscles during maximum voluntary contraction

The findings of the study showed significant bilateral asymmetry among selected group of lower limb muscles. Among selected group of muscles of lower limb vastus lateralis showed highest bilateral asymmetry and gastrocnemius showed lowest bilateral asymmetry. The findings is also supported by Fukuda et.al (2010) that vastus lateralis showed highest level of electrical activity.

The selected muscles of the left leg i.e., vastus lateralis, vastus medialis, rectus femoris and gastrocnemius showed significant difference from right leg in electrical activity during maximum voluntary contraction. It may be due to during take –off phase the left foot is considered as dominant foot of the spiker and due to alternate approach technique at moment take –off the momentum of the body is controlled by left foot in case of right handed spiker as well as body weight is on outer side of the left foot also creates greater stress on vastus lateralis due to absorption of maximal ground reaction force. Other selected muscles also showed significant difference which requires training concentration on non dominating foot for better performance

4. Conclusion

Research suggest that due to variation in electrical activity of muscles during maximum voluntary isometric contraction coaches have to concentrate on the non dominating foot and plan the training program accordingly for the enhancement of the performance of volleyball players, which also plays more or less same contribution during jumping movements. Understanding of bilateral asymmetry induced by different muscle actions is important to prevent muscle imbalance and also to avoid injuries.

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Author Profile



Dr. Amar Kumar obtained M.P.E, M.Phil and Ph.D from Laksmibai National Institute of Physical Education and presently working as Assistant professor in the L.N.I.P.E, Gwalior. I have 5 years of teaching experience and having area of specialization in the field of Sports Biomechanics and Volleyball