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Electromyographical Analysis of Hamstring Muscles during Sprint Start

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Abstract

Objective of the Study: The purpose of this study was to analyze hamstring muscle group activation of trained female sprinters at the time of movement phase in sprint start and examined the average level of activation of hamstring muscle group in trained female sprinters.

Material and Methods: Participant: Trained 8 female sprinters took part in the study. The mean age of the sprinters was 20 years, body mass 51kg, body height 161 cm, BMI 21.3kg/m^2, the duration of training experience 4 years. **Procedure:** The testing EMG equipment **(NeuroTracMyoPlus 2/4)** consisted 4channel surface electromyography, in this present study only 2 channels were used. The total EMG analysis was conducted with the use of NeuroTrac Software. The criterion measures for Electromyographical analysis is microvolt (µv) and for 50mt performance of sprinting in athletics is seconds. **Statistical Analysis of Data:** The means and standard deviations were calculated by using the SPSS 20.0 version software. The obtained data thus collected were statistically analyzed by employing descriptive statistics. **Conclusion:** The study was concluded that according to the result of average value of EMG Activity, semitendinosus muscle is also a very important muscle in the biomechanics of sprinting of female athlete. Its activity in the execution of movement phase shows highest value among monitored muscles. Its main role in the sprint start phase is to extend the hip and flex the knee to propel the lower limb forward in the sprinting stride. The female trained sprinters hamstring muscle group activate appropriate in the movement phase during sprint start.

Keywords: Electromyographical Analysis, Hamstring Muscles, Sprint Start

INTRODUCTION

The surface electromyography (EMG) is a method used to analyze muscular condition during rest or functional activities **(Fukuda, Thiago et.al 2010**). It is a technique to capture and measure the electrical activity and changes of muscles electrical potential and makes possible an investigation of muscle synergies, as well as muscle predominance in specific patterns of movement **(Thiago Yukio Fukuda, Jorge Oliveira Echeimberg et.al. 2010)**. According to physiologists, muscles and nerves are the major instruments of physical movement. The movement initiate in the body when the upper motor neurons from the motor cortex of brain send action potentials which travelling down your corticospinal tract (spinal cord) where they synapse with lower motor neurons which continue to propagate the signal to the designated muscle fibres. There, each single motor neuron and the muscle fibres they innervate create a "motor unit". At this neuromuscular junction, a neurotransmitter called acetylcholine is released which leads to the generation of an action potential in the muscle fibre. Upon receiving this excitatory signal, the muscles fibres contract and movement initiate **(Bowers W. Richard, Fox L. Edward, Foss L. Merle 1989).** It's important to realize that even when you are not moving your muscles constantly working at your service to maintain posture. Even when you are in slouching position your brain is commanding muscles to contract. It is important to understand that when you think to make any movement or even just to stand still, our brain (specifically the motor cortex) is sending action potentials along our nerves to not just one but multiple muscles to coordinate the movement with control or simply just to stay balanced and upright **(Tim and Greg 2009).**

Electromyogram (EMG) is a technique for evaluating and recording the activation signal of muscles. EMG is performed by an electromyograph, which records an electromyogram. Electromyograph detects the electrical potential generated by muscle cells when muscle contract and relax **(Bartlett Roger, Jhoniel Viloria2015, 2008).** . The lower leg is the part of the lower limb that lies from hip to thigh, thigh to knee and from knee to the ankle which makes up the lower limb. The terms lower limb or lower extremity is commonly used to describe all the leg **(M.A.M^{ac}Conaill, J.V.Basmajian1969).**

In this present study, the hamstring muscle group is taken into consideration for Electromyographic analysis during the sprint start. The hamstring muscles group; bicep femoris, semimembranosus and semitendinosus these muscles allow extension of the hip and flexion of the knee joint. The hamstrings work with gracilis, sartorius (adductors) and gastrocnemius (calves) in knee flexion, and also include biceps femoris and semitendinosus. During the sprint start when athlete on the command of "go" initiate starts without any delay then the sprinter's leg actions are as follows: after coming off the rear starting block, the push-off leg starts to drive forward, i.e. the thigh is rapidly drawn forward and upward. At first, the leading leg remains in an approximately horizontal position. Only when the foot passes the stretching leg, that is when the visible lifting of the thigh begins, will the leading leg begin to come forward somewhat. The front leg completes its extension as the rear leg completes its swinging action. In this stretching phase, this typifies the crouch start, the thigh of the swinging leg forms in most sprinters almost a right angle between the thigh and the trunk and between the thigh and the lower leg. The power produced by the extension of font leg must act optimally on the runner's centre of gravity. This implies that the extended leg and the trunk must form a nearly straight line **(Chris Husbands2013)**. According to Harland and Steele, the start can account for approximately 5% of the total race in the event 100 m races. The sprint start involves near-maximal muscle activation and complex, functional movements of an athlete's gross musculature **(Brown, A.M., Kenwell et al)**. A powerful start is crucial to attaining an optimal standard of performance in a sprint race **(Mero, A., Kuitunen et al)**. Three key contributors to the sprint start are reaction time, movement time and response time. Minimizing the duration of these components can contribute to faster start time, and ultimately a better sprint performance because it has been observed in the sprint literature that reaction time is the time it takes to initiate the response to a given stimulus. In the sprint start, the stimulus is the sound of the start gun and reaction time is measured by the first change in force after the gun **(Chris Husbands, Aditi Majumdar, Robert Robergs 2011, 2013).** Movement time is the onset of the response until the end of the movement. In the sprint start, movement time is monitored from the end of reaction time, when the force by the rear foot on starting block is 0 Newton's, to when the same foot has completed its first-foot successful strike on the ground. Total response time in the sprint start is the time interval that begins at the onset of the "go" signal and halts at the completion of the movement, the first foot strike response time is, therefore, a resultant of the reaction time and movement time combined. Both legs are equally important in the overall task of the sprint start **(Chris Husbands, Aditi Majumdar, Robert Robergs 2011, 2013).** Neuromuscular system and muscular skeleton system work together to give sprinters the ability to move with support and stability in the initial stage of a sprint start. The sprint start is best characterized as the period of time between the moment the sound of the starting gun has been received and the moment both feet have cleared the starting blocks **(Chris Husbands, Aditi Majumdar, Robert Robergs 2011, 2013).**

The aim of the study was to measure the EMG activity of hamstring muscle group during sprint start followed by crouch start in medium start. The Hamstring muscle group comprises the biceps femoris, Semimembranosus and Semitendinosus muscles; these allow extension of the hip and flexion of the knee during block start. Record average EMG signal by NeuroTracMyoPlus EMG System can enable to see average EMG signal among trained female athletes. So that can able to analyses the average muscle activation among female sprinters.

Objective of the Study

The purpose of this study was to analyze hamstring muscle group activation of trained female sprinters at the time of movement phase in sprint start and examined the average level of activation of hamstring muscle group in trained female sprinters. Sprinters for both leg hamstring muscles when sprinter first strike first step and second step strike on track.

Material and Methods

Participant: Trained 8 female sprinters took part in the study. The mean age of the sprinters was 20 years, body mass 51kg, body height 161 cm, BMI 21.3kg/m^2, the duration of training experience 4 years.

Procedure: The testing EMG equipment **(NeuroTracMyoPlus 2/4)** consisted 4channel surface electromyography, in this present study only 2 channels were used. The total EMG analysis was conducted with the use of NeuroTrac Software. The criterion measures for Electromyographical analysis is microvolt (µv) and for 50mt performance of sprinting in athletics is seconds. Before the actual testing, the subjects were given a complete demonstration of sprint start and after the demonstration and explanation according to manual standard; the electrodes were placed on selected muscle groups following SENIAM project procedures. Electromyography test was conducted on tentative athletic track in biomechanics lab of Physical Education Department, B.H.U Varanasi (U.P). 50mt sprint test was conducted in athletic ground (Amphitheater) of Banaras Hindu University, Varanasi.

Methods : The use of EMG allowed examination of performance of the rear leg and front leg hamstring muscle group activation of sprinters. The session of the study was preceded by a 15-min general warm up consisting of fitness and stretching exercises from top to bottom body parts. Participants then performed three sprinting trials, with 2 to 4 min rest breaks, depending on one's individual heart rate. Surface electrodes (Ag/AgCl) were placed on lower limb of participant's skin. The movement phase were determined on the basis of video recordings from two cameras, recorded visible movement of both leg when sprinter first strike their first step and second step on track after getting command of 'GO'. The muscle activation of selected muscles group was recorded by using EMG (NeuroTracMyoPlus 2/4). The EMG signal of the muscles consist in the sprint start were noted down as single unbroken recordings from detached block to the completion of first two steps. Best trail result of each participant's recorded by the EMG system and cameras were taken for detailed analysis.

Statistical Analysis of Data: The means and standard deviations were calculated by using the SPSS 20.0 version software. The obtained data thus collected were statistically analyzed by employing descriptive statistics. The results are depicted with help of table: 1

TABLE-1: Descriptive Statistics of 50mt Female Sprint Performance in relation to Electromyographic Hamstring Muscle Group Activation of Rear leg & Front Leg during Sprint Start

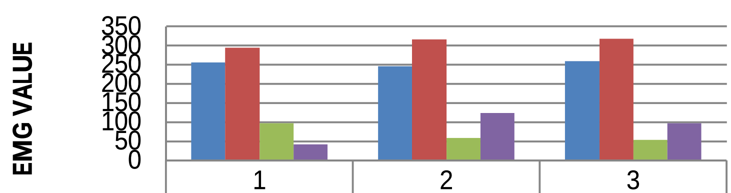
	Performance	**BF (RL)**	**Semimbs (RL)**	**Semitnds (RL)**	**BF (FL)**	**Semimbs (FL)**	**Semitnds (FL)**
N	8	8	8	8	8	8	8
Mean	8.7675	257.5250	247.0375	260.1375	295.2250	317.1875	319.1250
Std. Error of Mean	.15954	34.51424	21.04502	19.17541	14.86882	44.05952	34.76172
Std. Deviation	.45124	97.62101	59.52430	54.23625	42.05536	124.61915	98.32099
Variance	.204	9529.862	3543.143	2941.571	1768.654	15529.933	9667.016
Skewness	-.058	1.600	.411	-.914	-.479	1.857	1.309
Std.Error of Skewness	.752	.752	.752	.752	.752	.752	.752
Kurtosis	-1.284	1.247	.500	2.071	.332	3.883	.557
Std. Error of Kurtosis	1.481	1.481	1.481	1.481	1.481	1.481	1.481
Range	1.21	259.00	194.80	187.00	133.00	386.30	278.50
Minimum	8.07	192.50	155.50	152.60	219.20	208.40	226.10
Maximum	9.28	451.50	350.30	339.60	352.20	594.70	504.60

Where, Performance of 50mt sprint in seconds. (BF: Bicep Femoris), (Semimbs: Semimembranous), (Semitnds: Semitendinous), (RL: Rear Leg), (FL: Front Leg)

Descriptive Result of the Study

It is evident from table-1 that mean, standard deviation, Average EMG signal value of hamstring muscle group activation during sprint start followed by medium type crouch start have been found as follow: In case of Rear leg first contact, Semitendinous shows highest EMG activation with the mean (260.1375) and standard deviation (54.23625), bicep femoris have mean (257.5250) and (97.62101) and Semimembranous shows lowest activation with mean (247.0375) and standard deviation (59.52430). In case of front leg first contact, Semitendinous shows highest EMG activation with the mean (319.1250) and standard deviation (98.32099), Semimembranous have mean (317.1875) and (124.61915) and Bicep femoris shows lowest activation with mean (295.2250) and standard deviation (42.05536). in case of 50meter sprint performance have mean (7.5313) and standard deviation (.17812).

FIGURE-1:Graphical Representation of Mean Score & Standard Deviation of Hamstring Muscles Activation of Rear Leg and Front Leg during Sprint Start



	1	2	3
Mean (Rear Leg)	257.525	247.0375	260.1375
Mean (Front leg)	295.225	317.1875	319.125
Std. Deviation (Rear Leg)	97.62101	59.5243	54.23625
Std. Deviation (Front Leg)	42.05536	124.61915	98.32099

Where, hamstring muscle group denoted by 1= bicep femoris, 2= semimembranous,3= Semitendinous

Discussion

The purpose of this study was to analyze hamstring muscle group activation of trained female sprinters at the time of movement phase in sprint start and examined the average level of activation of hamstring muscle group for both legs in trained female sprinters when sprinter first strike first step and second step strike on track. As the descriptive result of this study, from the average of three hamstring muscle fibres: biceps femoris, semimembranosus and semitendinosus, act on both hip joint and knee joint, the semitendinosus shows highest EMG activation in both the cases i.e in first, the mean (260.1375) and standard deviation (54.23625 & in second, mean (319.1250) and standard deviation (98.32099).

During the sprint start when athlete on the command of “go” initiate starts then from the rear starting block, the push-off leg starts to drive forward, i.e. the thigh was rapidly drawn forward and upward. At first, the leading leg remains in an approximately horizontal position. Only when the foot passes the stretching leg, that was when the visible lifting of the thigh begins, the leading leg begin to come forward somewhat. The semitendinosus joined with muscles fibre diagonally whose function is to extend the hip and flex the knee under given pattern of movements. The front leg completes its extension as the rear leg completes its swinging action **(Mero and Komi 1990, Francavilla et al. 2018)**. In this stretching phase, this typifies the crouch start, the thigh of the swinging leg forms in most sprinters almost a right angle between the thigh and the trunk and between the thigh and the lower leg **(Magill, 1993; Monda et.al 2017)**.

The action potential generated by the extension of font leg act optimally on the runner’s hamstring muscles group. The result of EMG activation of semitendinosus muscle fibre showed higher due to these phenomena of sprint start. The study of **Mero & Komi 1990** reveals that Electrical action in a few muscles began to increase after complete response time because of the multijoint character of the sprint start movement. After the gun signal, leg extensor muscles must contribute maximally to the generation of force and at last to the running speed. The quicker the electrical activity starts in each muscle the quicker one can boost the neuromuscular execution. For enhancing the starting action, it is need that all extensor muscles are activated before any force can be distinguished against the block**.**

The literature from the study of **(Tait McKenzie, W.P Bowen 2017)** says that the semitendinosus named from its long tendon of insertion, which reaches half-way up the thigh; it is a close companion of the biceps. The origin of this muscle is from the tuberosity of the ischium, by a common tendon with the biceps and the insertion of this muscle is from the lower front side of the inner tuberosity of the tibia, along with the sartorius. The structure of this muscle reveals that the short muscle fibres pass diagonally downward from the tendon of origin to join the tendon of insertion, the bulk of the muscle being in the upper half of the thigh. In a previous study mentioned that the conditions under which the semitendinosus acts makes it plain that it can extend the hip and flex the knee just like the biceps, but with opposite rotary action on both hip and knee. The tendency to the rotation of the hip is less than that of the biceps. Isolated action of the semitendinosus verifies these conclusions and shows that, like the biceps, it acts with the most power on the hip.

Conclusion

The study was concluded that according to the result of average value of EMG Activity, semitendinosus muscle is also a very important muscle in the biomechanics of sprinting of female athlete. Its activity in the execution of movement phase shows highest value among monitored muscles. Its main role in the sprint start phase is to extend the hip and flex the knee to propel the lower limb forward in the sprinting stride. The female trained sprinters hamstring muscle group activate appropriate in the movement phase during sprint start.

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