Effect of the Squat Variations Exercises on the Electromyography Activity of the Hamstring Group of Muscles

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Abstract

The purpose of the study was to saw the effect of the squat variations exercises on the electromyography activity of the hamstring group of muscles. Ten subjects were institute selected with the age ranging from 18 to 25 years LNIPE Gwalior by using convenience purposive sampling selected for the present study. The subjects were enough experienced to perform front and back squats, athlete of any game which has well known about squat exercise variation. In this study hamstring group muscle taken as dependent variables and placement of feet in normal & wider stance during squats variation taken as independent variables. Surface Electromyography was used to measure the muscles activities during the various squat position and Medicom MTD software of elite version 5.4.16.2 were used to record the data. Raw EMG signals were recorded using an optic fiber wire that is directly connected to A/C encoder. An extended video camera was synchronized with the software to find out the EMG activity of the selected muscles at the time of performing variation of squats. The main effect of different variation of stance, main effect of exercises and interaction effect between stance and exercise on hamstring group of muscles during different squat exercise by using the two-way ANOVA Test were used at the0.05 level of significance. Result of this study revealed that there was no significant difference in electrical activity of hamstring group of muscle during performing normal back squat & wider back squat exercise. Thus it may be concluded that hamstring group of muscles activation was same in both stance of squat exercise.
KEYWORDS: Electromyography, Squat variation, Hamstring group of muscles.

Introduction

Muscle activity is one of the major factors associated with human body movements during sports, exercise, and survival in different daily life tasks. In general, surface electromyography (EMG) is used to measure the activity of superficial muscles and is an essential tool in biomechanical and biomedical assessments (Heinonen, 2012).

In strength training and fitness, the squat is a compound, full body exercise that trains primarily the muscles of the thighs, hips and buttocks, quadriceps (vastuslateralis, vastusmedialis, vastusintermedius and rectus femoris), hamstrings, as well as strengthening the bones, ligaments and insertion of the tendons throughout the lower body. The lower back, the upper back, the abdominals, the trunk muscles, the costal muscles, and the shoulders are isometrically involved when squatting with the proper form (Rippetoe, 2007).

Squats are known as the “King of All Exercises” for the simple reason that no other leg exercise challenges the gluteus, quadriceps, hamstrings, adductors, erectors, calves, abdominal stabilizers, etc. quite the way squats do. The squat also relies on muscle activity at both the hip and ankle joints and recruits the abdominals and spinal erectors as well. Squatting will not only help you develop leg and hip strength, but also promote full-body mobility and stability (Gullett, 2009).

The squat can be called a structural exercise, as well as a closed kinetic chain exercise. Structural exercises load the spine directly, whereas closed kinetic chain exercises have the hands and feet in a fixed position, and also is a multi-joint exercise (compound). A multi-joint exercise recruits many different muscle groups to complete the exercise. The squat works various muscles like the erector spinae, the core musculature, gluteus muscles, quadriceps, hamstrings and calves. When we perform the squat properly we are forced to maintain a rigid torso and a neutral neck, this alignment limits the amount of strain on the lower back. The same posture forces the core musculature to engage in an isometric contraction as well. When we flex at the hips and knees we’re working the hip flexors and quadriceps while engaging the calves. As we raise the weight back up and we extend the hip and knees the gluteus muscles, hamstrings and calf muscles begin to work (life style and strength, 2012).

Athletes and persons concerned with fitness regularly perform the back squat; the front squat is performed much less often. Although both squats effectively work the lower back, hip, and leg muscles, there are slight variations in technique and muscular involvement. In addition, the maximum amount of weight an individual can lift varies between the two techniques, with increased capacity possible for the back squat (Gullett JC, 2009).

Due to the popularity of the exercise, many variations have been created by altering the placement of the squat bar: back squat (barbell held across the back slightly above or below the level of the acromion), front squat (barbell held in front of the chest approximately at the level of the clavicles) (Donnelly, 2006).

Variations of the loaded barbell squat are widely used in the physical preparation programs for athletes in many sports. The primary reasons for this are the functional nature of the squat exercise movement, the ability to overload the muscles during this exercise, and the relative safety of the squat when performed in a squat rack or cage (Escamilla, 2001).

Electromyography (EMG) is the clinical study of the electrical activity of muscle fibers individually and collectively. This electrical activity can be recorded via surface or needle electrodes, the latter being used far more commonly in the clinical setting, and is evaluated during needle insertion, during periods of rest (spontaneous activity), and during periods of voluntary muscle contraction (Daube JR, 2009).

The surface electromyographic signal (sEMG) reflects the degree of activation of skeletal muscles and certain that the sEMG is highly correlated to the muscle force(Catherine, 2009).

The aim of this study was to compare the neuromuscular activity of the hamstring group of muscles (biceps femoris (BF), semitendinosus (ST) and semimembranosus through theuse of surface electromyography (EMG) in males performing the squat exercises.

Methodology

Selection of subjects:

10 college male students with the age ranging from 18 to 25 years are selected for the present study by using convenience purposive sampling. The subjects were experienced enough to perform front and back squats, athlete of any game which has well known about squat exercise variation.

Selection of variables
Dependent Variables:
1. Electromyographic activity of Hamstring group of muscles:
   i. Biceps femoris
   ii. Semitendinosus
   iii. Semimembranosus

Independent Variables:
1) Feet Position during Stance of Squat:
   a) Normal
   b) Wide
2) Exercise Variation:
   i) Barbell Back Squat narrow (BBSN)
   ii) Barbell Back Squat wide (BBSW)

Criterion measures:

To measure the criteria for variation of the squat exercises on muscles electrical activity through the Surface Electromyography (SEMG) is a non-invasive technique for measuring muscle electrical activity that occurs during muscle contraction and relaxation cycles. Subject will perform 1 repetition of different squat with surface electrodes position on the hamstring muscles. A familiarization session was carried out 1 week before testing for knowing 10 RM of the participants. The subjects were asked to warm up (jogging) for 3–5 minutes at the beginning of the session. The SEMG signal generated by the muscle fibers is captured by the electrodes, then amplified and filtered by the sensor before being converted to a digital signal by the encoder.

Electromyographical Setup:
Surface EMG was used for recording the muscles activity of all selected muscles. EMG signals were recorded using biographinfiniti 5.1.2 software system of Thought Technology Ltd. Montreal, Canada. SEMG signals were preamplified by driver Microsoft window 7 compatible with 32-bits with oprational setting i.e. common mode rejection ratio (CMRR) more than 130db, band-pass filtered at 20-500 Hz, input impedance more than 100 MΩ, maximum input voltage 7.26V (± 0.02V) and converted (10 bits) at a sampling rate of 256 Hz per second.

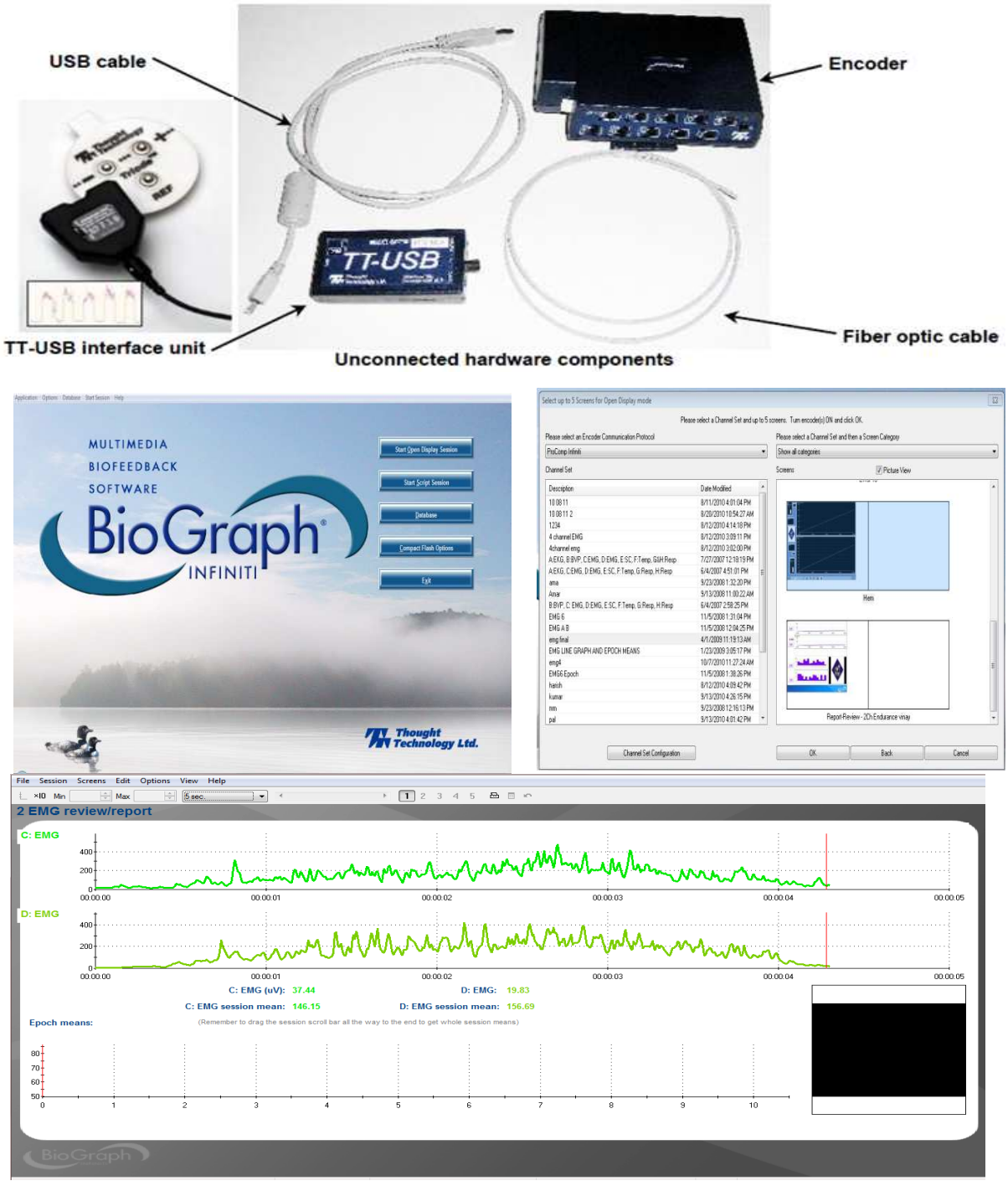

Figure-1: Biograph Infiniti 5.1.2 Two Channel EMG Software System

Skin Preparation and Electrodes Placement:

The skin surface at each site was shaved, rubbed with light abrasive paper, and cleaned with conductive gel to remove dead surface tissue and oils that might reduce the fidelity of the signal. The electrodes (Myo Scan-Pro) were placed on the midline of

muscles belly, between the myotendinous junction and the nearest innervations zone, with the detection surface oriented perpendicularly to the length of muscle fibres.

Figure-2
Placement of the Electrodes andTaping on different muscle of lower extremities

Exercise of squats variation:

All the subjects were instructed to perform barbell back squat exercise in normal and wide stance.

Figure-3
Barbell Back squat are performed in normal stance

Figure-4
Barbell Back Squat are performed in wide stance

In this experimental design every subject perform the 2 squat variation (barbell back narrow, barbell back wide) and sufficient recovery time was provided to the participants after completing each exercise.

Procedure for collection of data:

Surface Electromyography analyzers were used to measure the muscles activities during the various squat position and Medicom MTD software elite version 5.4.16.2 are used to record the data. After shaving and applying the abrasive cream to the electrodes, the EMG electrodes were placed parallel to the muscle fiber on appropriate location of the hamstring muscles. EMG signals were recorded using an optic fiber wire that is directly connected to A/C encoder. An extended video camera was synchronized with the EMG software to find out the maximum voluntary contraction (MVC) of the selected muscles at the time of performing the exercises. The following consideration will be kept in mind during administration of EMG:

i. Researcher will make sure that all electrodes will be placed in all three muscles according to their appropriate anatomical reference points.

Statistical Technique:

To find out the main effect of different variation of stance, main effect of exercises and interaction effect between stance and exercise on hamstring group of musclesduring different squat exercise two-way ANOVA Test were used at 0.05 level of significance.

Table1.
Descriptive statistic of electromyography of hamstring group of muscle during Squat exercises

Stance of Squats	Muscles of Hamstring	Mean	Std. Deviation	N
Normal	Biceps femoris	124.39	98.63	10.00
	Semitendinosus	290.16	515.14	10.00
	Semimembranosus	302.48	642.95	10.00
Wider	Biceps femoris	105.56	55.24	10.00
	Semitendinosus	271.49	441.44	10.00
	Semimembranosus	404.16	746.91	10.00

Finding pertaining to the descriptive statistics of electromyography of hamstring group of muscles during squat in normal & wide stance has been presented in Table 1. The values of mean and standard deviation of biceps femoris, semitendinosus & semimembranosus were shown in Table 1.

Table-2

Two-way ANOVA table for the data on electromyography of hamstring group of muscle during Squat exercises

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Squat stance	6864.91	1	6864.91	.03	.87
Hamstring muscle	597154.22	2	298577.11	1.24	.30
Squat stance x hamstring muscle	48336.66	2	24168.33	.10	.90
Error	12998565.65	6	240714.18		
Corrected Total	13650921.4[a]	59			

a. R Squared = .048 (Adjusted R Squared = -.040)

The p-value for the Squat stance, Hamstring muscle and interaction (stance x muscle) in Table 2 are more than .05; hence, all the three F-values are not significant at 5%level. Thus the null hypothesis for the Squat stance, Hamstring muscle and interaction (Stance x Muscle) may be fail to be rejected at .05 level of significance. Now the post hoc comparison analysis shall not be done for these factors and interaction.

Discussion and Conclusion

From above results it is found that there is no significant difference between the adjusted mean of stance (normal & wide) and electrical activity of hamstring groupmuscle during squat exercises of barbell back squat normal (BBSN) and barbell back squat wide (BBSW). Thus it may be concluded that activation of hamstring group of muscles was same in both stance i.e. (normal & wide).

Results from several investigations involving that the placement of the foot was not a significant result on hamstring group of muscles during performing squat exercises.Clark et.al., (2012)was investigated that the common variations such as stance width, hip rotation, and front squat did not significantly affect muscle activation.Antonio et.al., (2009) was analyzed that there were no significant difference concerning the EMG activity of the biceps femoris, semitendinosus muscles in squat exercise. Wright et.al.,(1999) also found that hamstring activity during the squat is minimal.

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