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ELECTROMYOGRAPHIC CHANGES FOLLOWING SPRINT SPECIFIC PLYOMETRIC PROGRAM IN SPRINTERS

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Abstract:
Purpose: The ability to reach a high running velocity over a short period of time is essential for sprinters. Sprinting requires appropriate muscle recruitment for an athlete to perform. The purpose of this study was to determine the effect of the sprint specific plyometric training on electromyographic (EMG) changes in sprinters. **Methodology:** 40 university sprinters volunteered and were randomly assigned into two groups, group 1 (G1; n=20) sprint specific plyometric training group(mean age 18.65±0.875; mean height 164.10±11.30 cm; mean mass 59.20±10.74 kg) and group 2 (G2; n= 20) control group (mean age 18.95±1.19; mean height 166.60±9.80 cm; mean mass 61.60±9.24 kg). Both sprint specific plyometric training group and control group were assessed for

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neuromuscular activity of lower limb muscles by telemetric Noraxon TELEMYO U.S.A., Inc.v3.1.10 machine. Subjects in training group performed six weeks sprint specific plyometric protocol thrice a week. The EMG activities in the tibialis anterior (TA), vastus lateralis (VL), rectus femoris (RF), medial gastrocnemius (MG) and semitendinosis muscle (ST) were assessed pre and post training. **Results:** The results showed significant changes ($p<0.05$) in the EMG activities for the mean amplitude of RF(rt), MG(lt), ST(rt) muscles and maximum periods of TA(rt), VL(rt), MG(lt) and ST(rt) muscles. **Conclusion:** The study demonstrates that the neuromuscular training program can increase the muscle recruitment to perform high intensity activities hence, can be recommended to coaches for athletes or individual.

Keywords: electromyographic changes, specific plyometric program, sprinters

1. Introduction

Sprinting is a running short distance event on track and field in a limited period of time. Plyometric exercises plays an integral role in strength and conditioning or in performance enhancement regardless the phase it has been used.(1) Plyometric used in the measurement of sports performance outcomes such as throwing velocity, jump height or sprint speed.(2,3,4)

Plyometric training is involved in every sports to increase strength and explosiveness of muscles.(5) Sprint running contributes in various sports for successful performances. Plyometric exercises used for training the athlete should match the characteristics of their sporting activity they are involved with. That is, to optimize the activity by the principle of specificity. For example, only jumping specific exercises will not increase the running speed.(6,7) Plyometric is a type of training which have the ability to develop force at high speed in dynamic movements. These dynamic movements include the stretch of muscle immediately followed by an explosive contraction of the muscle. This is also termed as stretch-shortening cycle (SSC).(8)

One of the measures to determine the muscle recruitment in the muscles is by electromyography. The EMG signal is the algebraic sum of the motor units potential activity where the electrode is placed. These motor units are usually not active simultaneously and function at different times. The contraction or expansion of muscle cords depends on the signals that reach a motor unit at that time. A motor unit will become active and its muscles will contract only when the amount of excitatory impulses are more than inhibitory impulses and higher than the level of threshold (9). Strength can be noted as athlete's most important physical attribute and plays an important role in every sport. Using plyometric exercises in sports needing a lot of strength is of greater importance. Muscle power depends on the amount of nerve stimulation and the number of active motor units.(10) Through creating changes in muscle's nervous system, plyometric training increases the ability of muscle group in responding faster and stronger to muscle changes.

Thus, through EMG results, better training methods and facilities can be considered for athletes. Reviewing different studies, it seems that physiological activities that are influential to neuromuscular adaptations in power training and that lead to an increase in the power and strength.

2. Material and Method

A total 40 university level sprinters (mean age, height, mass) volunteerd and were randomly allocated in two groups, Group 1 (G1; n = 20) sprint specific plyometric training group and Group 2 (G2; n = 20) control group. The procedure, benefits and potential risks of study was explained to the subjects before the test started and duly signed informed consent was taken. It was insured that the subjects were free of any musculoskeletal conditions or any neurological dysfunctions. This study was approved by the Institutional Ethics Committee of MYAS-GNDU Department of Sports Sciences and Medicine, Guru Nanak Dev University, Amritsar, Punjab.

The allocated grouped participants of the study agreed not to change or increase their current exercise routine during the course of the study. The sprint specific plyometric training group participated in a six week exercise program thrice a week which included various jumping, bounding and sprinting exercises designed (table 1) where the control group continued their routine training schedule. Participants were tested before and after the six weeks training period. The procedure was conducted using telemetric Noraxon TELEMYO U.S.A., Inc.v3.1.10 machine. The readings of total 10 muscles (5 on each side was taken) which included the tibialis anterior, vastus lateralis, rectus femoris, medial gastrocnemius and semitendinosis. The readings were taken while running on treadmill on speed of 2.7m/s for 30 seconds before and after six weeks period [11].

Table 1: 6-week exercise program performed by the Subjects in the Plyometric Group Sprinting based program

Plyometrics program			Sprint program	
Week	**Exercise**	**Sets**	**Sprint distance (m)**	**Repetition**
1	Double leg tuck jump	5×8	40	5
	Double leg speed jump	5×8	40	5
2	Double leg tuck jump	5×8	40	5
	Single leg tuck jump	2×5	25	2
	Double leg speed jump	5×8	40	5
3	Double leg bound	2×6	50	2
	Single leg tuck jump	2×8	40	2
	Double leg speed jump	4×10	55	4
	Single leg hop	4×8	40	4
4	Double leg bound	4×6	50	4
	Single leg tuck jump	2×8	40	2

	Single leg hop Alternate leg bound	4×8 5×8	40 40	4 5
5	Single leg hop Single leg speed hop Alternate leg bound Alternate leg stair bound	2×8 2×8 8×8 3×8	40 35 40 30	2 2 8 3
6	Single leg hop Single leg speed hop Alternate leg bound Alternate leg stair bound	2×8 2×8 7×10 3×10	40 35 50 40	2 2 7 3

Source: Rimmer, E and Sleivert, G. Effects of plyometric intervention program on sprint performance. *J Strength Cond Res* 14: 295-301, 2000.

3. Results

3.1 Mean Amplitude

Table 2: Descriptive statistics values of EMG of
bilateral rectus femoris muscle in sprinters

Rectus femoris	**Experimental group**		**Control group**	
	Pre	**Post**	**Pre**	**Post**
Right	19.44±63.80	54.93±85.55	-1.23±21.85	24.19±139.84
Left	22.98±96.17	94.45±136.64	1.76±34.11	25.79±73.95

Table 2 represents mean amplitude of vastus lateralis muscle. In between group comparison the experimental group ($p<0.04$ lt and $p<0.16$ rt) and control ($p<0.86$ lt and $p<0.47$ rt), experimental group showed significant difference on left side post training.

Table 3: Descriptive statistics values of EMG of
bilateral medial gastrocnemius muscle in sprinters

Medial gastrocnemius	**Experimental group**		**Control group**	
	Pre	**Post**	**Pre**	**Post**
Right	32.44±98.07	41.0±76.65	22.50±116.27	17.14±101.35
Left	-3.60±23.03	30.83±49.64	2.38±11.51	4.08±11.0

Table 3 represents mean amplitude of vastus lateralis muscle. In between group comparison the experimental group ($p<0.03$ lt and $p<0.00$ rt) and control ($p<0.58$ lt and $p<0.62$ rt), experimental group showed significant difference bilaterally post training.

Table 4: Descriptive statistics values of EMG of bilateral semitendinosus muscle in sprinters

Semitendinosus	Experimental group		Control group	
	Pre	Post	Pre	Post
Right	20.44±65.52	166.68±267.32	22.94±56.68	51.24±217.66
Left	78.91±143.82	94.30±152.31	81.69±161.57	54.40±125.67

Table 4 represents mean amplitude of semitendinosis muscle. In between group comparison the experimental group (p<0.70 lt and p<0.03 rt) and control (p<0.30 lt and p<0.58 rt), experimental group showed significant difference on right side post training.

3.2 Maximum Periods

Table 5: Descriptive statistics values of EMG of bilateral anterior tibialis muscle in sprinters

Tibialis anterior	Experimental group		Control group	
	Pre	Post	Pre	Post
Right	4405.75±3288.84	7032.8±2617.25	6309.9±2949.0	5044.6±3209.64
Left	5342.95±3634.91	6844±2884.33	6148.8±2915.38	6333.8±3442.40

Table 5 represents maximum period of tibialis anterior muscle. In between group comparison the experimental group (p<0.13 lt and p<0.00 rt) and control (p<0.81 lt and p<0.15 rt), experimental group showed significant difference on right side post training.

Table 6: Descriptive statistics values of EMG of bilateral vastus lateralis muscle in sprinters

Vastus lateralis	Experimental group		Control group	
	Pre	Post	Pre	Post
Right	5277.93±3264.64	7382.3±2324.81	5506.5±3112.87	5403.15±3104.81
Left	5328.45±2898.40	6332.55±3325.56	5480.9±3392.28	5201.9±3398.67

Table 6 represents maximum period of vastus lateralis muscle. In between group comparison the experimental group (p<0.23 lt and p<0.00 rt) and control (p<0.78 lt and p<0.90 rt), experimental group showed significant difference on right side post training.

Table 7: Descriptive statistics values of EMG of bilateral medial gastrocnemius muscle in sprinters

Medial gastrocnemius	Experimental group		Control group	
	Pre	Post	Pre	Post
Right	6037.05±3041	5853.35±3141.11	5685.9±3113.05	4911.95±3035.82
Left	4318.55±3591.15	6543.9±3060.48	4058.2±3327.13	4111.4±3328.43

Table 7 represents maximum period of medial gastrocnemius muscle. In between group comparison the experimental group (p<0.01 lt and p<0.83 rt) and control (p<0.96 lt and p<0.37 rt), experimental group showed significant difference on left side post training.

Table 8: Descriptive statistics values of EMG of bilateral semitendinosus muscle in sprinters

Semitendinosis	Experimental group		Control group	
	Pre	Post	Pre	Post
Right	4380.85±3773.45	7620.75±2438.31	3959.95±3709.15	3523±3317.14
Left	5434.95±3039.83	6492±3354.90	6548.8±2975.95	5987.9±2970.57

Table 8 represents maximum period of semitendinosis muscle. In between group comparison the experimental group ($p<0.08$ lt and $p<0.00$ rt) and control ($p<0.31$ lt and $p<0.74$ rt), experimental group showed significant difference on right side post training.

4. Discussion

The present study aim was to measure the dynamic electromyography of tibialis anterior, medial gastrocnemius, rectus femoris, vastus lateralis and semitendinosis muscles bilaterally. This mainly included averaged mean amplitude of all periods and averaged maximum of all periods in uV (microvolt) bilaterally. Present study found the activity of rectus femoris (lt), medial gastrocnemius (lt) and semitendinosis (rt) to be significantly improved in their mean amplitude whereas tibialis anterior (rt), vastus lateralis (rt), medial gastrocnemius (lt) and semitendinosis (rt) improved in their averaged maximum of all periods. The study postulated by Rezaimesh et al., (2001) and Hakkinen et al., (1986) reported significant changes in the motor unit recruitment and rate of force developmemt for the lower body muscle. It determines that plyometric training adds much force and tension to muscle cords. Physiological or biological changes in muscle cords and other parts of the contraction system causing muscle electromyographic activity to rise, is the result of tolerating extreme forcefull activities and tension in the muscles (Rezaimanesh et al., 2001). Study done by Abbas Asadi (2011) suggested that plyometric training on sand increased EMG activities of the muscles as a result of absorptive qualities of sand, which increases contraction time, allowing leg extensor muscles to build up an active state and force prior to shortening. Singh et al (2018) evaluated the effect of 6 weeks of agility training program in taekwondo players in which they concluded about changes in left biceps femoris muscle which is in accordance with the present study. Higashihara et al (2010) analysed the BF and ST and compared their muscle activity over trials of increased running speed, a potentially greater risk of hamstring strain as sprint speed increased was proposed. Present findings are not in line with Mehdipour et al's (2008) study. They examined the effects of 6 weeks plyometric training on rectus femoris muscle activity and did not find significant difference. Some of the reasons for such a variety of results may be noted as the difference in type and intensity of exercise. This study emphasized that 6 week sprint specific plyometric training sessions had a significant effect on the EMG changes on muscles. These types of exercises can be used for preparation seasons, as well as competition seasons to increase lower-body muscle recruitment in sprinters and other games for improving performance.

5. Conclusion

The study concludes that the neuromuscular training program can increase the proprioception and explosiveness of lower extremity which increases the muscle recruitment to do high intensity physical activities in sprinters as well as other sportspersons. Hence, this type of training program can act as an adjunct to the already specified training schedule of sprinters.

Conflict of Interest
There were no conflicts of interest.

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