

Research Paper

Comparison the Timing of Lower Limb Muscles Activity in the Stance Phase of Running Between Athletes with Reconstructed Anterior Cruciate Ligament and Healthy

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How to Cite this Article:

Mardazad A, Farahpour N, Hoseini Y. Comparison the Timing of Lower Limb Muscles Activity in the Stance Phase of Running Between Athletes with Reconstructed Anterior Cruciate Ligament and Healthy. *J North Khorasan Univ Med Sci.* 2020;6(4):59-69.

DOI: 10.29252/jjrn-06047

Received: 05 Nov 2019

Accepted: 09 Mar 2020

Keywords:

Running

Anterior Cruciate Ligament

Electromyography

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Rehabilitation Research in Nursing

Abstract

Introduction: After reconstructing the anterior cruciate ligament, to prevent re-injury of the ligament, evaluation of neuromuscular function is of clinical importance in coordinating the onset time and time to peak of lower limb's muscles activity. Aim: Therefore, the purpose of this study was to compare the timing of muscle activity in the stance phase of running between athletes with reconstructed anterior cruciate ligament and healthy subjects.

Methods: This study was a semi-experimental and applied type. Ten athletes with reconstructed anterior cruciate ligament who at least one year had passed since their surgery, as experimental group and ten healthy subjects as the control group of Hamedan city were volunteered to participate in the study. The control group, in terms of age, height, and weight, were homological with the experimental group. The surface electromyography system was used to quantify the onset time and time to peak of the lower limb's muscle activity. Multivariate MANOVA, with a significance level of $P < 0.05$, was used for statistical analysis.

Results: In the experimental group, the onset of the activity in tibialis anterior, medial gastrocnemius, vastus medialis, vastus lateralis, gluteus medius ($P = 0.001$), as well as the time to peak in tibialis anterior, vastus lateralis, vastus medialis, gluteus medius, semitendinosus ($P = 0.001$) and biceps femoris ($P = 0.045$), were delayed.

Conclusions: During the stance phase of running, the experimental group displayed a delay in the activation onset and a longer time to peak in the lower limb's muscles. It is not clear if these changes are due to a neuromuscular adaptation or proprioception related damage. A more comprehensive study is recommended to clarify this aspect. It is recommended to assess the possible link between these delays with the reoccurrence of anterior cruciate ligament rupture.

Extended Abstract

OBJECTIVE

Anterior cruciate ligament rupture is more common knee injury in athletes and, in addition to joint mechanical instability, due to disturbance of the knee proprioception system, it causes poor balance and loss of athletic performance [2]. After reconstructed anterior cruciate ligament, the

amount of activity and lifestyle changes [6], and there is often the risk of osteoarthritis and meniscus tear in these people [7]. Regarding the mechanism of anterior cruciate ligament rupture, it is believed that excessive mechanical loading at the knee simultaneous with rapid deceleration, abrupt change of direction during landing

or running, are important risk factors for this injury [8, 9]. In maneuvers accompanied by changes in acceleration and direction of movement, the lower extremities may be in a locked position. In these conditions, excessive ankle pronation, internal tibial torsion, Knee valgus and external rotation of the thigh occurs that the anterior cruciate ligament is overloaded suddenly and these are the leading causes of ligament rupture [10]. Muscles are responsible for the distribution and absorption of these dynamic loads on the lower limbs [15]. At this stage, the nervous-muscular system decreases the mechanical forces applied to the knee by controlling the duration of the activity, the intensity of exercise, and the onset of use [16]. In the running, the lower extremity is continuously subjected to mechanical load stress, and this loading becomes more severe with fatigue and loss of muscle function. During running slowly, the loads fall below the physiological threshold level. However, sometimes due to mechanical conditions and inadequate muscle response when performing the maneuvers, the total exceeds overtime interval, and the rupture of the anterior cruciate ligament occurs [12]. When the anterior cruciate ligament is damaged or replaced by a graft, many of the primary mechanoreceptors and neural connections are not restored. In addition to the mechanical function of the anterior cruciate ligament, this ligament provides essential sensory information for understanding the joint status and detecting threshold motion and muscle reflex stability to maintain collective balance [44]. After reconstructing the anterior cruciate ligament, to prevent re-injury of the ligament, evaluation of neuromuscular function is of clinical importance in coordinating the onset time and time to peak of lower limb's muscles activity. Therefore the purpose of this study was to compare the timing of muscle activity in the stance phase of running between athletes with reconstructed anterior cruciate ligament and healthy subjects.

MATERIALS AND METHODS

This study was a semi-experimental and applied type. Ten athletes with reconstructed anterior cruciate ligament who at least one year had passed since their surgery, as experimental group and ten healthy subjects as the control group of Hamedan city were volunteered to participate in the study. The control group, in terms of age, height, and weight, were homologous with the experimental group. Surface electromyography system was used to quantify the onset time and time to peak of lower limb's muscles (tibialis anterior muscle, medial gastrocnemius muscle, lateral gastrocnemius muscle, vastus medialis muscle, vastus lateralis muscle, semitendinosus muscle, biceps femoris muscle and gluteus medius muscle) activity in the stance phase of running. For both groups, each subject runs three times on an 18 m path in the lab at an average speed of 2.5 m / s (9 km / h). Running gear was calculated based on the kinematic data from the cameras. Each repetition of the

tests was allowed if the individual moved at a specified speed and landed on the force plate device with the leg reconstructed. Multivariate MANOVA, with a significance level of $P < 0.05$, was used for statistical analysis.

RESULTS

In the experimental group, the onset of the activity in tibialis anterior muscle, medial gastrocnemius muscle, vastus medialis muscle, vastus lateralis muscle, gluteus medius muscle ($P = 0.001$) as well as the time to peak in tibialis anterior muscle, vastus lateralis muscle, vastus medialis muscle, gluteus medius muscle, semitendinosus muscle ($P = 0.001$) and biceps femoris muscle ($P = 0.045$) were delayed.

CONCLUSION

During the stance phase of running, the experimental group displayed a delay on the activation onset and a longer time to peak in the lower limb's muscles. These delays may be related to the recurrence of anterior cruciate ligament or the occurrence of osteoarthritis. It seems that people with anterior cruciate ligament surgery due to proprioception abnormalities during injury as well as residual proprioception abnormalities after surgery and neuromuscular system changes have delayed onset of activity and time to peak muscle activity. Therefore, delays in the start of the event and the time to peak of the productive force of these muscles are risk factors. Periodically, Muscle rehabilitation should be taken seriously to increase muscle strength and coordination and Improvement proprioception receptors in these patients after surgery. It is not clear if these changes are due to a neuromuscular adaptation or proprioception related damage. A more comprehensive study is recommended to clarify this aspect. It is recommended to assess the possible link between this delay with the reoccurrence of anterior cruciate ligament rupture and occurrence osteoarthritis.

Ethical Considerations

This research was confirmed by the Ethics Committee of Medical Studies of the University of Medical Sciences Hamedan on 2/3/1394 with number 1199/9/35/16 / p. Subjects signed a consent form to participate in the study after being informed of the purpose and method of the research. Also, the information of the participants in this study was kept confidential.

Funding or Supports

There was also no funding or supports.

Author's Contributions

Mr. Amin Mardazad Navi: He did Writing and preparing the initial and final drafting, statistical analysis, submitting and paper revision, and laboratory work. Mr. Nader Farhpour: He did the initial idea of studying and checking the initial draft of the article. MR. YASIN HOSSEINI: He did the initial design of studying and paper revision and laboratory work.

Conflict of Interest

The authors of the article do not declare any conflict of interest.

Applicable Remark

This study will be useful for the rehabilitation of people after anterior cruciate ligament surgery and can also help people during running to prevent anterior cruciate ligament injury and osteoarthritis and ultimately a healthy lifestyle

Acknowledgments

This article is the result of Mr. Amin Mardazad's thesis with the supervisor of Dr. Nader Farahpour approved by the University of Bu Ali Sina Hamadan. This research was confirmed by the Ethics Committee of Medical Studies of the University of Medical Sciences Hamedan on 2/3/1394 with number 1199/9/35/16 / p. We appreciate all the relevant Officials as well as all the athletes who participated in the study. Medical Studies of University of Medical Sciences Hamedan on 2/3/1394 with number 1199/9/35/16 / p. We appreciate all the relevant Officials as well as all the athletes who participated in the study.