STUDIA UBB EDUCATIO ARTIS GYMN., LXVII, 4, 2022, pp. 131-136
(RECOMMENDED CITATION)
DOI:10.24193/subbeag.67(4).41

COMPARISON BETWEEN UNIPEDAL AND BIPEDAL PLANTAR FLEXIONS USING TIME UNDER TENSION METHOD

PĂTRAŞCU Adrian[1,*], TRONCIU Matei[2]

Received 2022 October 08; Revised 2022 November 21; Accepted 2022 December 05; Available online 2023 March 10; Available print 2023 March 30.

ABSTRACT. ***Introduction.*** Bodybuilding is a sport that requires all muscle groups to be similarly developed, bringing an aesthetic physique to the observers. The development of the triceps surae may be a difficult goal to achieve for some athletes. Considering this, we chose to focus on a new training method that induces less stress in muscle groups: the time under tension. ***Objective***. The purpose of the study was to compare exercises used for calf hypertrophy using the time under tension method and to identify the optimal situations in which this method could be used. ***Methods***. Ten subjects, 6 male and 4 female, age of 25.7±4.9 years old, height 174.7±9.5 centimeters, body weight 82±17.8 kg and with varied levels of fitness, participated in the study. The plantar flexions were done with body weight only on one and both feet. The exercises we tested were done on a 3 second cycle: 3 seconds on the upwards movement and 3 seconds for the downwards one. The subjects performed a total of 10 repetitions for each exercise. ***Results.*** A significant statistical difference was found between the types of plantar flexion measured. This indicates that the analysis of time under tension plantar flexion should take into account the actual type of movement done. ***Conclusions***. Time under tension method for calf muscle hypertrophy should take into consideration the movement characteristics for the focused muscle group. Our results showed that postural balance and body position can influence the force and power output of plantar flexion.

Keywords: *time under tension, triceps surae, plantar flexion, calf muscles, forces.*

[1] *Research Assistant, Faculty of Physical Education and Sport, Babeş-Bolyai University, Cluj-Napoca, Romania*
[2] *Undergraduate, Faculty of Physical Education and Sport, Babeş-Bolyai University, Cluj-Napoca, Romania*
[*] *Corresponding author: adrian.patrascu@ubbcluj.ro*

Background

Sports performance is the notion used for the special results obtained in competitions following a training plan. Trying to improve the deficient aspects brings new solutions, new strategies and ideas. Man is the only being capable of self-knowledge, a being that feels the need to evolve and assert himself both in his eyes and in the eyes of others. That is why every result obtained motivates the athlete to continue. In sports, we talk about performance and achievement as an essential and characteristic reason for athletes (Bompa & Buzzichelli, 2019; Noffal & Lynn, 2012).

Muscle hypertrophy is a complex process with many factors involved, continuous adaptation of muscle fibers and must be stimulated in different ways for the best results. Thresholds that need to be crossed to stimulate muscle mass growth vary from person to person and no one can naturally reach them passively. This process can be seen after about seven weeks of following an effective training plan. Also, this process can take longer or less depending on age and gender (Blaauw & Reggiani, 2014).

Because the means we used in this experiment use the TUT method it is important to know the minimum requirements of intensity and mechanical work that must be achieved to stimulate muscle hypertrophy (Taber et al., 2019).

In 2018, a study is carried out whose results prove that exercises with an intensity of at least 40% of 1RM (one repetition with maximum weight) performed until volitional failure can cause an increase in muscle mass to a similar extent as those that are performed with a greater intensity even when their volume is equalized (Lasevicius et al., 2018).

In 2019, another study carried out on 23 female subjects between the ages of 21 and 27 without sports training shows us that exercises performed until volitional failure with an intensity of 30% of 1RM benefited from the same results as those performed with an intensity of 80% both increased muscle mass and strength (Dinyer et al., 2019).

Another 2015 study of 18 highly trained male subjects between the ages of 18 and 35 with similar 1RM performance shows that athletes who used 30-50% of their 1RM with repetitions to failure had better results than those who used 80% of 1RM (Schoenfeld et al., 2015).

The Time under Tension (TuT) method can be implemented in the training program using any exercise at a different tempo of movement. It is important that the weight used by this method is at least 30% of 1RM to allow the athlete to perform repetitions over a time interval of at least 40 seconds. The TUT method involves the slow execution of the exercise, for a few seconds both in the concentric or positive movement but also in the eccentric or negative movement of the movement. This can be done with a tempo of at least 3-0-3, i.e. 3 seconds concentric part, 3 seconds eccentric part (Mang et al., 2022).

Objective

While there are a multitude of frequently used exercises for the triceps surae, we decided to investigate the forces generated in the less implemented Time Under Tension method. The aim of our research was to investigate, test and compare the bidepal and unipedal plantar flexions used by athletes practicing both recreational and performance fitness.

Methods

Subjects

Ten subjects, 6 male and 4 female, age of 25.7±4.9 years old, height 174.7±9.5 centimeters, body weight 82±17.8 kg and with varied levels of fitness, participated in the study.

Before the start of the study, the subjects were informed about its requirements and any ambiguities regarding participation were answered. The written consent to participate in the study was also received, as well as the consent for the processing of personal data, respecting the rules of ethics and deontology that a scientific research imposes.

Methods and the Steps of the Research

The plantar flexions under TuT method were measured on the BP400600HF force platform which can be used for engineering, medical studies, orthopedics and rehabilitation. It was designed for accurate ground reactive force measurement and measures the three orthogonal forces along the X, Y and Z axes producing a total of 6 outputs.

The test days began by preparing for exercise, i.e. performing a gentle warm-up of the joints for 10 minutes to prevent injury. After the warm-up, a test measurement was performed to accustom the subject both to the execution of the movement on the measuring platform and to acclimate them to the tempo of the exercise. For each individual subject, the ground force measurement platform was calibrated using the initial position of the exercise. Each subject performed 10 repetitions for each of the three types of plantar flexions: bipedal, right foot and left foot.

Each plantar flexion was performed with the tempo 3-0-3: i.e. 3 seconds concentric movement, 0 seconds maintaining the final position, 3 seconds eccentric movement so that each repetition has a total of 6 seconds. Between each repetition, the subject rested for 60 seconds to prevent the execution of a faulty movement and promote recovery. After completing the plantar flexions, the subject performed the post-exercise recovery of the body.

Results

Table 1. Descriptive statistics for the ascending and descending average forces for each of the 3 plantar flexions (bipedal, right food and left foot)

	Group	N	Mean	Std. Deviation	Std. Error Mean
F_ascend	Bipedal	10	49.38	11.33	3.58
	Right Foot	10	34.94	24.22	7.66
	Left Foot	10	28.36	15.06	4.76
F_descend	Bipedal	10	-43.84	13.97	4.42
	Right Foot	10	-87.92	28.69	9.07
	Left Foot	10	-71.23	13.65	4.32

Table 2. Results of the independent sample t test for the 3 plantar flexions (bipedal, right food and left foot) for the two conditions: ascending and descending forces

		N	t	df	Sig. (2-tailed)
F_ascend	Bipedal vs Right Foot	10	1.71	12.76	0.11
	Bipedal vs Left Foot	10	3.53	16.71	0.00
	Right vs Left Foot	10	0.73	15.06	0.48
F_descend	Bipedal vs Right Foot	10	4.37	18.00	0.00
	Bipedal vs Left Foot	10	4.43	17.99	0.00
	Right vs Left Foot	10	-1.66	12.88	0.12

An independent-samples t-test was conducted to compare ascending force in bipedal and left foot conditions. There was a significant difference in the scores for bipedal (M=49.38, SD=11.33) and left foot (M=28.36, SD=15.06) conditions: t (16.71) =3.53, p = 0.00. These results suggest that TuT method does have an effect on ascending force between bidepal and left foot.

An independent-samples t-test was conducted to compare descending force in bipedal and left foot conditions. There was a significant difference in the scores for bipedal (M=43.84, SD=13.97) and left foot (M=71.23, SD=13.65) conditions; t (17.99) = 4.43, p = 0.00. These results suggest that TuT method does have an effect on descending force between bidepal and left foot.

An independent-samples t-test was conducted to compare descending force in bipedal and right foot conditions. There was a significant difference in the scores for bipedal (M=43.84, SD=13.97) and right foot (M= 87.92, SD= 28.69) conditions; t(18.00) = 4.37, p = 0.00. These results suggest that TuT method does have an effect on descending force between bipedal and right foot.

The results of the independent-samples t-tests for the other conditions showed no statistical significant difference: bipedal and right foot forces on the ascending movement, right and left foot on both the ascending and descending movements.

Conclusion

The fact that there was no statistical difference between bipedal and right foot ascending forces but there was one between bipedal and left foot is interesting if viewed through the fact that all subjects were right hand dominant. TuT seems to influence the ascending forces differently depending on which part of the body has more dexterity. We suggest that a larger study should be conducted in the future to test this on a wider population because, if this is a general effect of TuT, it could mean that its implementation should be dependent on the dominant hand of the subject.

At the same time, there have been significant statistical differences between bipedal and either foot for the descending forces. It seems that from a neuromuscular control point of view TuT can influence the forces generated on either foot. Considering the fact that most of the work of the calfs is to push not to pull the body, this result may be normal. This means that TuT should be used for a more general workout of the calf muscles to cover both the eccentric and concentric movements.

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