Journal of Physical Fitness, Medicine & Treatment in Sports

Juniper Publishers key to the Researchers

Research Article
Volume 8 Issue 4 - November 2020
DOI: 10.19080/JPFMTS.2020.08.555741

J Phy Fit Treatment & Sports

Metabolic, hemodynamics and performance of traditional resistance training vs. Ponto zero method

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Submission: October 05, 2020; **Published:** November 03, 2020

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Abstract

The purpose of this study was to compare metabolic, hemodynamic and performance of traditional (TRA) resistance training vs. Ponto zero method. Sixteen recreationally trained men (26.6±5.1 years old; 83.4±13.9 kg; 176.7±7.1cm; 26.60±3.39BMI) participated in this study. Subjects visited the laboratory four times, in which the first visit, anthropometrics data was measured, and the second visit consisted of 10 repetition maximum (RM) test performed in the elbow flexion with straight bar. In the TRA protocol, subjects were oriented to flex their elbows in the concentric phase and fully extend, back to the starting position, during subjects the eccentric phase. In the Ponto zero, five-seconds of isometric action was used in the 120º elbow flexion in each repetition. In both protocols, subjects were instructed to perform three sets of 10 repetitions with 60% of 10 RM and two-min rest interval between sets. The volume load (total repetitions x load) was the same between conditions, however, Ponto zero showed significantly greater time under tension (TUT) and rating of perceived exertion (RPE) in all sets when compared to TRA ($p < 0.001$). Blood lactate increased significantly only immediately after session in the TRA ($p = 0.015$), and Ponto zero increased significantly immediately after, 30-min and 60-min time-points ($p < 0.001$). Similar reductions in diastolic blood pressure was observed in both sessions ($p < 0.05$). In conclusion, Ponto zero seems to be a good alternative of method to increase TUT, RPE and metabolic stress.

Keywords: Metabolic; Hemodynamic; Anthropometrics; Fernando Sardinia; Elbow flexion; EF exercise; Baseline

Abbreviations: RT: Resistance training, TUT: Time under tension; RPE: Rating of perceived exertion; ROM: Range of motion; EF: Elbow flexion; RM: Repetition maximum

Introduction

Resistance training (RT) methods has been widely investigated in literature as a possibility of manipulation of prescription [1-3]. Previous studies showed benefits of RT methods in development of muscle hypertrophy [4,5], strength [6,7], power [7] and muscular endurance [5]. In addition, studies showed that the greater acute stress of these methods with greater muscle swelling, lactate (La-) concentrations and rating of perceived exertion (RPE), which can contribute to adaptations related to RT [4,8]. In this sense, the Ponto zero is growing popularity and widely used by bodybuilders as a possibility to increase training intensity without increase the load. The method was created by a Brazilian competitor and coach Fernando Sardinia and consists in an isometric sustained contraction at the end of the movement in a total duration of five seconds in each repetition. This sustained contraction is at the point of greater moment arm, and the movement is not executed in a full range of motion (ROM). This partial ROM has been suggested that may not compromise muscle hypertrophy [9-11] but has an angle-specific adaptation for muscle strength [11]. Besides that, the addition of an isometric action in the point of greater moment arm can increase the time under tension in the point of greater force production, mainly in single-joint exercises, which the muscle of interest is the primary mover [10].

Time under tension (TUT) should consider the contraction velocities of different phases of movement (concentric and eccentric) and if there is an isometric contraction, as proposed by Ponto zero [10]. Previous studies suggested that greater TUT increase metabolic stress, which generally is measured by post exercise blood La- [4,8]. Recently, studies measured muscle

thickness to indicate cellular swelling because of increased metabolic demand and related to chronic hypertrophy [8,12,13]. In addition, alterations of post exercise blood pressure (BP) and heart rate (HR) is observed as consequence of increased blood flow to the active muscle do deliver substrate and remove metabolites. Thus, RT methods that promote acute metabolic stress can be advantageous for chronic adaptations [8,12,13]. Based on it, the aim of the present study was to compare metabolic, hemodynamic and performance of traditional (TRA) vs. Ponto zero RT methods performed in a single-joint exercise. The initial hypothesis is that Ponto zero will promote greater metabolic and hemodynamics alterations due to higher TUT.

Methods

Subjects

Sixteen recreationally trained men (26.6±5.1 years old; 83.4±13.9kg; 176.7±7.1cm; 26.60±3.39BMI) participated in this study [Table 1]. To be included, subjects should be trained in RT at least six months, between 20 and 35 years old and familiarized with elbow flexion with straight bar (EF) exercise. Were excluded of the study those with recent historical of injuries in upper body and using ergogenic agents. All subjects answered the PAR-Q questionnaire and if had any affirmative answer, subject was excluded. During experimental procedures, subjects were oriented to avoid any king of supplements, especially thermogenic, antioxidants and vitamins. Subjects that are using any kind of anti-inflammatory medicines were excluded.

For ethical procedures, subjects were oriented about all experimental procedures that they were submitted in a consent term that should be answered if they are in accordance with all conditions. This study was conducted in accordance with the norms of the Brazilian National Health Council, under resolution no. 466/2012, referring to scientific research on human subjects and the Helsinki Declaration. This study was approved by University Ethic Committee under the number 28461920.1.0000.5257.

Experimental Approach to the Problem

This was a within-subjects repeated-measures study, in which all subjects visited the laboratory four times, separated by 48-72 hours. During the first visit, anthropometrics measures (height and weight) was measured and subjects were oriented about all experimental procedures. In addition, the first visit was used for familiarization session which participants performed the Ponto zero method in a total of three sets of 10 repetitions, with submaximal load, based on their training routine and 2-min rest interval between sets. In the second visit, 10 repetition maximum (RM) test was performed in the EF exercise. During sessions three and four, subjects underwent to two experimental protocols (TRA and Ponto zero) performed in a randomized crossover design.

Ten repetition maximum test

During the second session, subjects underwent 10RM to determine the load for the EF exercise [14,15]. The initial load was estimated based on the weight performed in the familiarization session. Before starting the test, one set was considered a warm-up with 50% of the estimated load. Three to five attempts were used with three to five minutes of rest interval between trials. The higher load obtained was used in the experimental sessions. To reduce the margin of error during the test, the following strategies were adopted: 1) Standardized instructions were offered before the test so that the subject was aware of the whole routine that involves data collection; 2) The subject was instructed on the exercise execution technique; 3) The evaluator was aware of the position adopted by the participant at the time of the test, as small variations in the positioning of the joints involved in the movement could trigger other muscles, leading to erroneous interpretations of the scores obtained; verbal stimuli were performed to maintain a high level of motivation. The individuals were instructed not to ingest any stimulating substance (caffeine or alcohol) and not to perform physical activity on the day before or on the day of the tests [3,16]. The mean 10 RM load obtained was 37.5±6.8 kg.

Experimental protocols

In the EF exercise, subjects were oriented to position the arms extended along the body and the hands in a supinated position gripping a straight bar. In the TRA protocol, subjects were oriented to flex their elbows in the concentric phase and fully extend, back to the starting position, during subjects the eccentric phase. In the Ponto zero method, the ROM of the elbow flexion during the EF exercise was standardized prior session, with a goniometer, for each subject. A measure was taken in a lateral wall, in 120º of elbow flexion, for each subject to observe the moment arm that they should perform the isometric contraction (Figure 1). In both protocols, subjects were instructed to perform three sets of 10 repetitions with 60% of 10 RM and two-min rest interval between sets. In the Ponto zero, five-seconds of isometric action was used in the 120º elbow flexion in each repetition. If the subjects were not able to perform 10 repetitions with 60% of 10 RM in the Ponto zero, they were oriented to perform the following repetition without the isometric contraction. This strategy was adopted in order to promote a volume-equated condition between protocols (Figure 1).

Performance and Perceptual Response

For performance parameters, VL was measured using the following formula sets x repetition x load. The TUT was measured by visual analysis, which a 2d camera (PowerShot G7X Mark II; *Canon*®) captured each set duration and then it was analyzed in a software (Adobe Premiere PRO; Adobe *Systems*®). The TUT was considered the initial phase of the movement until the last repetition, returning the eccentric phase. Rating of perceived exertion was rated at the end of each set using OMNI-res scale, which 0 is considered an extremely easy set and rating 10 extremely hard set [17]. Metabolic Stress and Muscle Swelling. Blood La- concentration was assessed via a lactate analyzer (*Accutrend*®

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Plus; Roche) at baseline, immediately after (approximately 30-seconds), 30-min and 60-min after exercise. First, the finger was sterilized with alcohol and cotton, then a puncture was made with a spring-loaded single use disposable lancet. The first drop of blood was discarded and the second was inserted in the analyzer. In addition to La- concentration, it was measured the relative difference between baseline and post exercise time-points. Muscle swelling was measured with arm circumference in the right arm using a taper measure at baseline, immediately after (approximately 30-seconds), 30-min and 60-min after exercise. The arm circumference was measured at midpoint between acromion and olecranon and reported in millimeters.

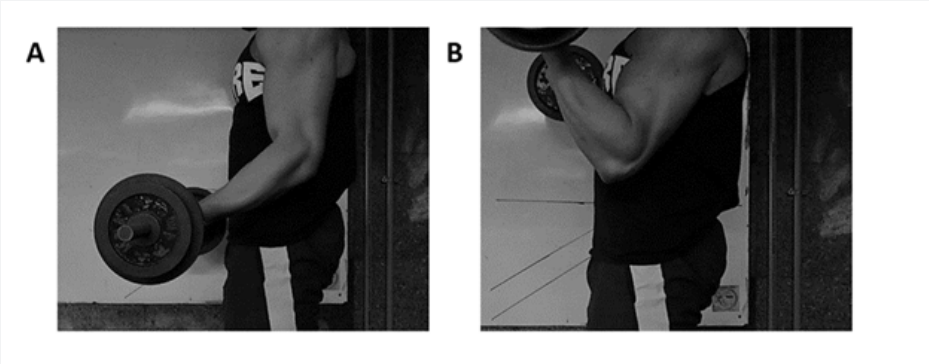

Figure 1: Ponto zero method in the starting position (A) and in the end of the movement (B).

Hemodynamics responses

Before each session, the baseline values of systolic blood pressure (SBP), diastolic blood pressure (DBP) and HR were determined after a 10-minutes rest period, in a seated position. All measures were performed in an sociometric way (OMRON HEM-7113, São Paulo, Brazil), in the seated position and in the left arm. Post exercise measures were performed immediately, 15-min, 30-min, 45-min and 60-min after session.

Statistical Analysis

For statistical treatment, Sigma Plot 11.0 was used (Germany). The statistical analyses were initially performed using the Shapiro-Wilk normality test and homoscedasticity test (Barlett's criterion). All variables showed normal distribution and homoscedasticity. A two-way repeated ANOVA with repeated measures was used to determine whether there were significant interactions between conditions at different time points for each protocol. For all measures, the Bonferroni post hoc was used to identify if there were significant differences and $p \leq 0.05$ was adopted for all inferential analysis. The Cohen's d effect size was calculated and classified according to Rhea [18]. The formula consisted of the difference between the baseline values to post-exercise values divided by the baseline standard deviation and classified as follows: <0.35 = trivial; 0.35-0.80 = small; 0.80-1.5 = moderate; >1.5 = large (Figure 2).

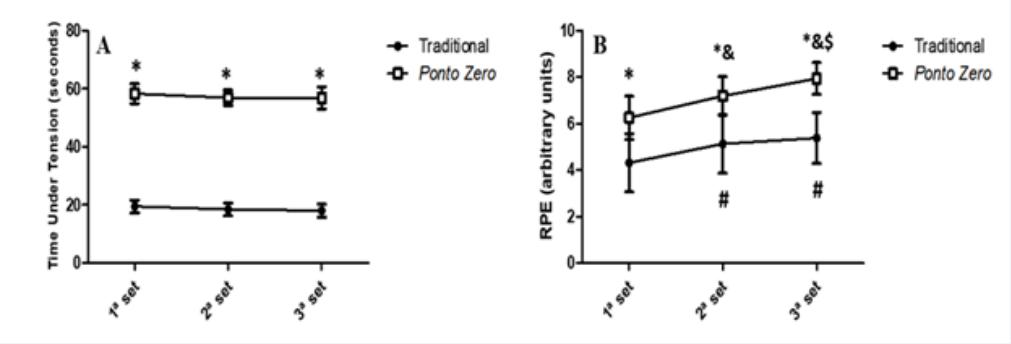

Figure 2: Time under tension (A) and rating of perceived exertion (B) in each set.
#significant difference for first set in traditional; & significant difference for first set in Ponto zero method; $ significant difference for second set in Ponto zero method; *significant differences between protocols.

Results

Performance and Perceptual Response

Subjects were able to complete three sets of 10 repetitions with 60% of 10 RM in both conditions. Thus, the VL of 189.4±61.7 kg was the same between conditions. For the TUT, a main effect for set ($F=7.742$; $p=0.002$) and condition ($F=3324.915$; $p<0.001$) was observed, without significant interaction. Ponto zero

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showed significantly greater TUT in all sets when compared to TRA ($p<0.001$). For the RPE, a main effect for set ($F = 49.821$; $p<0.001$) and condition ($F=120.273$; $p<0.001$) was observed with significant interactions ($F=3.987$; $p = 0.029$). In the TRA, RPE was significantly greater in second ($p<0.001$) and third set ($p< 0.001$) when compared to the first set. In the Ponto zero, RPE was significantly greater in second ($p<0.001$) and third set ($p<0.001$) when compared to the first set. In addition, the third set was significantly greater than the second set ($p = 0.002$). In all sets, Ponto zero showed significantly greater RPE when compared to TRA ($p<0.001$ for all inferential analysis)

Metabolic Stress and Muscle Swelling

For the La-, a main effect for time was observed ($F = 17.831$; $p < 0.001$), without significant interactions. Blood La- increased significantly immediately after session in the TRA ($p = 0.015$). In the Ponto zero, La- increased significantly immediately after, 30-min and 60-min time-points ($p < 0.001$ for all inferential analysis). For the arm circumference, a main effect for condition was observed ($F = 17.351$; $p < 0.001$), without significant interactions. The arm circumference increased significantly immediately after session for both TRA ($p = 0.001$) and Ponto zero ($p = 0.031$) (Figure 3).

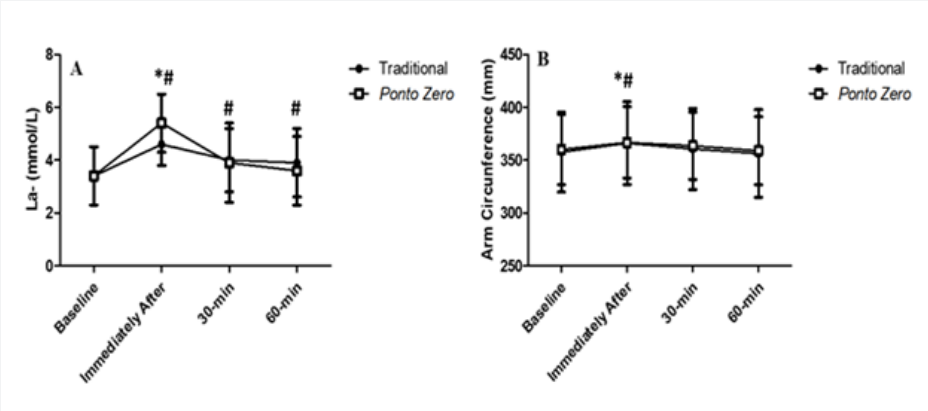

Figure 3: Blood lactate (A) and arm circumference (B) in different time-points.
*significant difference compared to baseline for traditional; # significant difference compared to baseline for Ponto zero method.

Hemodynamics responses

For SBP, a main effect for time was observed ($F = 5.605$; $p<0.001$), without significant interactions. Pairwise comparison did not reveal significant differences between baseline and post exercise time-points for both conditions. For DBP, a main effect for time was observed ($F = 21.721$; $p <0.001$). Significantly greater reductions in DBP immediately after ($p < 0.001$) and 15-min ($p = 0.004$) post exercise time-points when compared to baseline for TRA. In the Ponto zero, similar finding was observed with significant reduction of DBP immediately after ($p < 0.001$) and 15-min (p - 0.007) time-points when compared to baseline. For HR, a main time effect was observed ($F = 3.088$; $p = 0.014$), without significant interactions (Figure 4).

Discussion

The findings of this study revealed that although Ponto zero is a method without full ROM, the addition of an isometric contraction increased the TUT and interval load with greater increase in La- concentrations and RPE of the subjects. Alterations in muscle swelling, BP and HR were observed after session in both conditions, in a similar extent. In the present study, greater post exercise La- concentrations and RPE throughout sets in Ponto zero were attributed to greater TUT of this method when compared to TRA. Time under tension is generally manipulated with alterations in the cadence, slowing or accelerating the movement velocity of concentric-eccentric phases [19-22]. In a previous study, [23] compared a slow movement protocol (6-sec concentric and eccentric phases) with a traditional session with work matched (same number of repetitions). The results showed greater acute responses of myofibrillar, sarcoplasmic and mitochondrial protein synthesis rates when compared to traditional. Different from previous studies reported, Ponto zero increase the TUT in absence of full ROM and adding the isometric contraction in a point of great moment arm. This methodological approach contributes to explain the greater La- concentrations in this method. Although this suggests benefits considering muscle adaptations, specially hypertrophy, [24] reported no significant differences in the repetition duration for hypertrophy using 0.5-8 seconds, suggesting that although greater acute proteins synthesis, the chronic response is similar between slow movements and traditional.

Previous studies showed that in conditions of equalized TUT, protocols with greater VL and faster movements increases neuromuscular fatigue measured with electromyography and La- concentrations. This is mainly attributed to the concentric phase performed in faster velocities recruit greater number of motor

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units than slower and this increase the metabolic demand. In another study [4] evaluated the metabolic stress in two protocols of sarcoplasm stimulating training (SST) method, which one consisted of greater TUT slowing concentric-eccentric phase and adding isometric contractions. No significant differences were observed for La- when compared to TRA. The main reason of this divergent finding is that in this study, the VL between conditions was equalized and in the study of Almeida et al. [4], greater VL was observed for TRA. It is important to highlight that Ponto zero was performed in conditions of submaximal load which suggests that the addition an isometric contraction in a point of great moment arm increase the internal load. In conditions of submaximal intensity, the increase in TUT seems to be beneficial to promote greater metabolic stress, increasing La-, and for muscle adaptations [20,21].

In the Ponto zero method, the partial ROM, with absence of the initial phase of the movement of EF, did not impaired the acute response of metabolic stress. Recent studies showed heterogeneous muscle adaptations when performing protocols with partial or full ROM. Alamitos et al. [11] compared partial and full ROM of knee extension in an isokinetic chair with equalized TUT. The results showed greater alterations in fascicle length and when performing full ROM, otherwise, partial revealed greater alterations in physiological cross-sectional area. In another study, Kubo et al. [9] compared hypertrophy and strength adaptations when performing partial and full depth in the squat exercise. When considering knee extensor muscle, both protocols elicited similar hypertrophy, however, full squat showed significant greater hypertrophy for gluteus maximus and adductor when compared to half squat. In addition, the study revealed an angle-dependent strength adaptation, which full squat improved 1 RM results in both full and partial ROM, while half squat improved only partial ROM. Recently, Schoenfeld and Gric [25] showed that the majority of evidences corroborate for full ROM for muscle hypertrophy when considering lower limb, and there is limited evidence when considering upper limb. In this study, the EF is a single-joint exercise, performed with free-weights, and all these variables should be considered. Significant hemodynamics alterations were observed in both conditions, especially considering DBP that reduced significantly immediately after session. This result suggests a vasodilatation after exercise with increase blood flow to the elbow flexors muscles [26,27]. Hemodynamics responses were modest specially by the low-volume session, which consisted of only one exercise, with three sets [28]. In addition, EF is an exercise that recruit small muscle groups, and multi-joint or lower limbs exercises shows greater hemodynamics alterations based on greater muscle involved [29,30] Probably a session with different exercises performed with Ponto zero or TRA should reveal different responses considering hemodynamics responses. A limitation of this study is the small sample size; however, subjects were selected according to their experience in RT and specifically in the exercise used in the protocols. In addition, only one exercise was used in this study, and future studies with Ponto zero should consider a session, with multiple sets and exercises. Future studies should consider evaluate the metabolic stress of different methods with additional biochemical measures [31].

Conclusion

Ponto zero RT method showed greater concentrations of La- attributed to longer TUT and greater RPE. Otherwise, both protocols showed increased metabolic stress markers after sessions, suggesting that both conditions should be used in a RT. The addition of Ponto zero must be considered in sessions that aim lower mechanical tension, in detrimental of the load, and greater metabolic stress.

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