

EFFECT OF MAXIMUM VOLUNTARY ISOMETRIC CONTRACTION OF ANTAGONIST MUSCLES IN MAX TORQUE AND RATE OF TORQUE DEVELOPMENT OF AGONIST MUSCLES IN TRAINED AND UNTRAINED WOMEN

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Abstract

The purpose of this study was to compare the effect of antagonist maximum voluntary isometric contraction on the torque and the rate of torque development of the agonist muscles in ankle joint in trained and untrained women at 0° angle joint. Twelve untrained and twelve trained women handball player participated in the study. An isokinetic dynamometer CYBEX Norm was used for the evaluation of torque. Initially the Maximal Voluntary Isometric Contraction (MVIC) both for plantar(PF) and dorsi flexors(DF) was evaluated. Afterwards the subjects performed 3 maximal isometric contractions of plantar flexor for 1 second, with 1 minute break between trials. After 10 minutes complete rest, 3 consecutive maximal dorsiflexion contractions and immediately after that three maximal PF contraction were performed for the evaluation of the reversal effect DF on PF. The following parameters were evaluated before and after DF contraction: Plantar flexion MVIC, Maximal Rate of Torque Development (MRTD), time of MRTD and the RTD for the period 0–30, 0–50, 0–100 and 0–200 ms after the torque onset. The statistical analysis showed that the reversal effect was presented only for the trained group for the MRTD and RTD 0–30. These results demonstrated that the existence of the reversal effect of the antagonists is not appeared always in untrained groups and especially for the joint angle it is affected by the training background only for selective parameters of muscle contraction.

Keywords: reversal of antagonists, trained, untrained, MVIC,RTD

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Introduction

The Rate of Torque Development (RTD) shows the change of torque in time, from the onset of torque to the time of appearance of the maximum isometric torque. These two parameters can be affected both by motor neurons and muscular parameters (Andersen & Aagaard, 2006). It is known that the relation between torque-speed and neuromuscular activity appear some differences, depending from the angular position of the measured torque (Simoneau, Martin & Van Hoecke, 2007).

An interesting point for the RTD enhancement was the Golgi Tendon Organ (GTD) function as stated by previous studies. Grabiner (1994) suggested that the RTD can be positively affected during a maximal isometric contraction preceded by a contraction of the antagonist muscle. This phenomenon is called Reversal of the Antagonist (REV). According to this phenomenon the preactivation of antagonist muscles could probably causes better performance during the contraction of agonist muscles. Kabat (1952), based on Sherrington's concept (1947), introduced the idea of REV, pretending that elementary reflexes interact to trigger a more complex process to coordinate agonist and antagonist action. This could be the explanation about the relation between REV and Golgi tendon organs (GTOs) function because when a muscle is contracted inhibits the function of agonist muscle and facilitates the antagonist, through Ib afferent. The exact nature of this mechanism has not experimentally been identified completed though several neuronal or muscular mechanisms have also been proposed (Roy et al., 1990). Regarding the effect of REV on muscle performance two cases have been analyzed: the peak torque and the RTD. Initially the REV effect was tested in hemiparetic subjects where peak torque enhancement was observed (Bohannon, 1985). However, this was not always the case for the healthy people, where in other cases positive effect (Kamimura, 2007; Kamimura, et al 2009; Roy et al., 1990) while in others no effect (Bohannon, Gibson, & Larkin, 1986) was reported.

Untill now the effect of the reversal was studied on two cases for strength and RTD enhancement. The majority of cases reported an effect only on RTD and not for the maximal torque (Gabriel, Basford, & An, 1997; Gabriel, Basford, & An, 2001; Kamimura, 2007). However a recent study (Kamimura, Yoshioka, Ito, & Kusakabe, 2009) reported REV effect on maximal torque. The explanation of their results was based on the fact that they used a contraction of the one second instead of two seconds which the previous studies did, considering that GTO effect lasts about one second.

Analyzing further the relevant literature it was revealed that the REV effect has not extensively measured in joint angle and especially there was no comparison between trained and untrained people. The last case is very important if it is considered that the possible higher values of strength could cause a higher strain on GTO and consequently enhanced reversal effect.

For this reason the purpose of this study was the investigation of REV effect in angle joint and the differences which may exist between trained and untrained persons.

Method

Participants

The sample was consisted of 12 untrained and 12 trained handball women. Handball players played in the first and second division of Greek championship while untrained were students of the

Department of Physical Education and Sport science. Anthropometric data are presented in table 1. All participants were familiar with the testing protocol and they gave their written consent, having been informed for the process. The experimental process was complied with the Ethics standards provided by the Aristotle University of Thessaloniki.

Table 1.
Anthropometric data of the participants

Group	Age (y)	Height (cm)	Body mass (Kg)
Trained	24,23 ± 31	1,68 ± 0,05	61 ± 6,11
Untrained	22,13 ± 1,84	1,73 ± 0,04	60,91 ± 7,94

Instrumentation

Dynamometry: The isokinetic dynamometer CYBEX Norm (Lumex Corporation, Ronkahoma, NY), according to manufacturing instructions regarding alignment of the specific platform that has the dynamometer for the measurement of the ankle joint.

Experimental protocol

The experimental protocol was consisted of three stages. Participants in the first stage performed 3 maximum isometric contractions of the plantar flexors for 1 second with 1 minute rest period between them. They rested for 10 minutes off the machine and they performed the second stage of the protocol. Participants in second stage performed 3 maximal 1 second maximal dorsiflexion isometric contractions. In the third stage they performed maximal 1 second plantar flexion for the evaluation of the REV.

Testing

For the MVIC both of plantar and dorsiflexors the participants performed 15–20 submaximal isometric contractions with gradually increasing intensity with 3 minutes rest interval. Participants were instructed to produce their maximal torque. Verbal motivation and visual feedback of the torque output was provided during the tests. The highest torque value was marked on the monitor and set as target to overcome for the rest trials. This procedure was repeated until the torque of the three best trials was not less than the 95% of the best one. The trial with the highest torque value was further analyzed and used as target value for the REV evaluation. All tests were performed on the dominant foot, at supine position, with hips flexed at 60°. The knee was set at full extension and the angle between the plantar surface of the foot and the tibia was set at 90°. The rotation axis of the dynamometer was approximately aligned with the rotation axis of the ankle. Non-elastic Velcro straps stabilized the foot on the platform and the subject's trunk and thigh on the dynamometer's chair.

Height and body mass were measured using stadiometer and a digital scale respectively, with subjects in light clothing and no shoes. Height and body mass were recorded to the nearest 0.1 cm and 0.1 kg, respectively (Sahaly, Vandewalle, Driss, & Monod, 2001).

Analysis of data

For RTD, torque onset was defined as the first point in time where torque reached 5 standard deviations of its baseline. Afterwards the following parameters were analysed. The method of calculating the rate of torque development was the following using Matlab package: Maximal RTD, time to Maximal RTD and the RTD in the 30, 50, 100, and 200 ms Interval.

Statistical analysis. The program Statistica was used for the statistical analysis. As dependent variables were defined: the values of maximum torque, the rate of torque development (RTD) and the times in which appeared these variables. Following independent variables were used: the group (trained-untrained), time of contraction, the angle measurement (0°) and the type of contraction (isometric, only maximum or reversal). In the analysis of data the model of analysis of variance was used: ANOVA for repeated measurements. The Tukey test was used for post-hoc analysis and level of significance was set at $p > 0.05$.

Results

The comparison in MIVC revealed statistical significant differences in trained persons in all conditions ($p < 0.05$), however no reversal effect was observed in both of the two groups ($p > 0.05$).

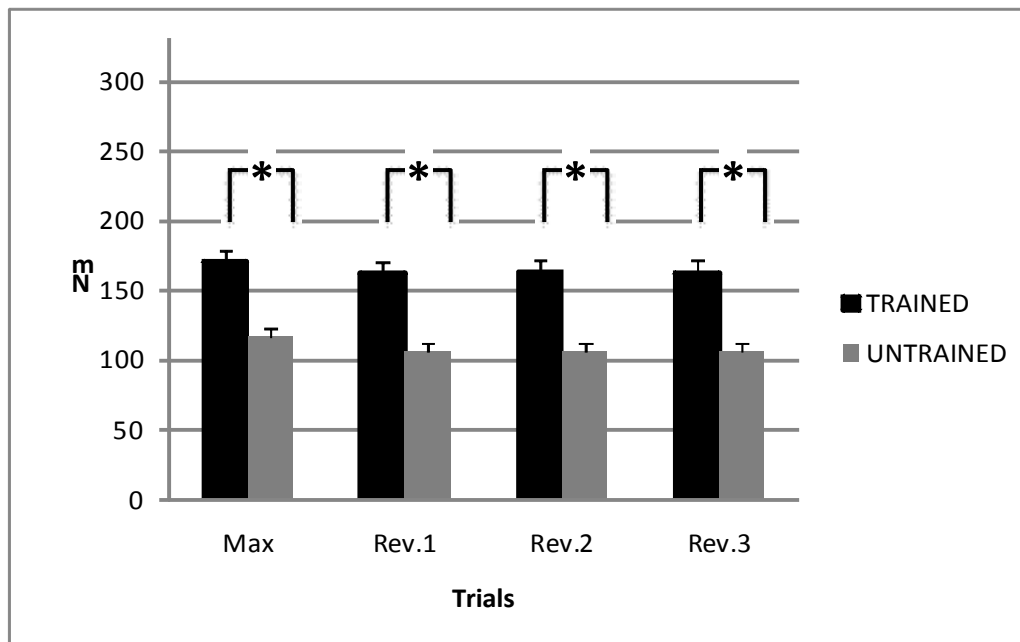


Figure 1. Reversal Effect on MVIC

Statistical analysis showed a tendency for a reversal effect on MRTD however this effect was not significant ($p > 0.05$). Higher values for MRTD was observed in all experimental conditions in trained group but it was not statistically significant ($p > 0.05$)

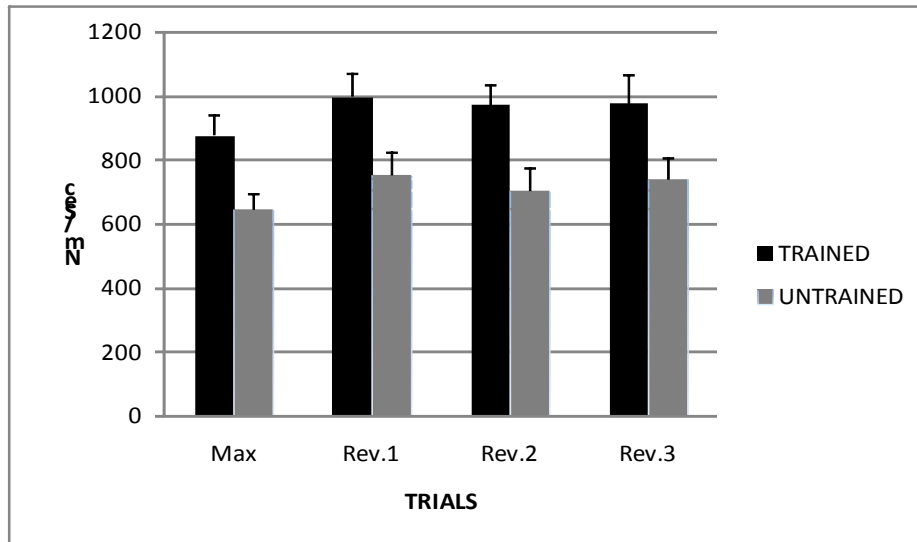


Figure 2. Reversal Effect on MRTD

The statistical analysis showed a reversal effect only for the trained group ($p < 0.05$). No effect was observed for the untrained group.

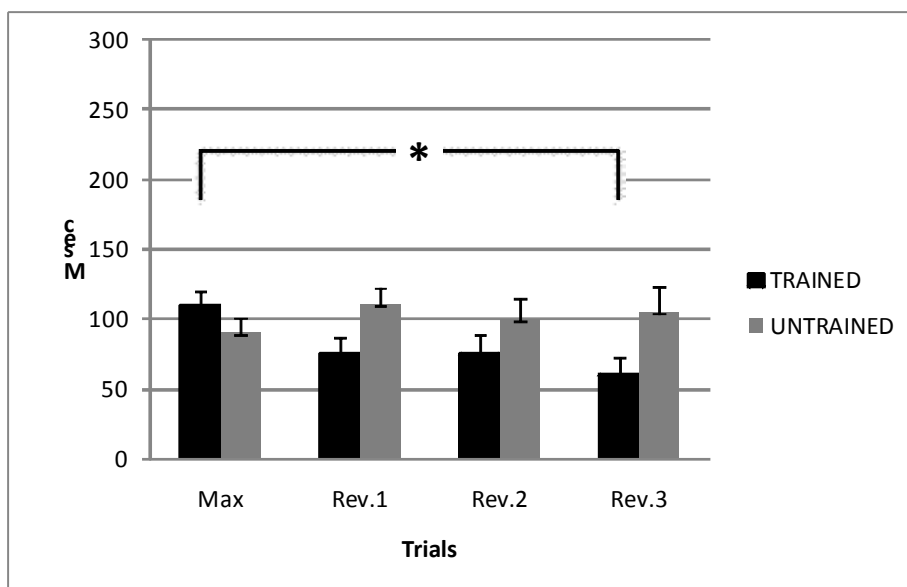


Figure 3. Reversal effect on the time for MRTD

The analysis of this parameter showed reversal effect only for the trained group ($p < 0.05$) but not for the untrained one ($p > 0.05$). In all cases the values for the trained group were higher for the untrained group ($p < 0.05$).

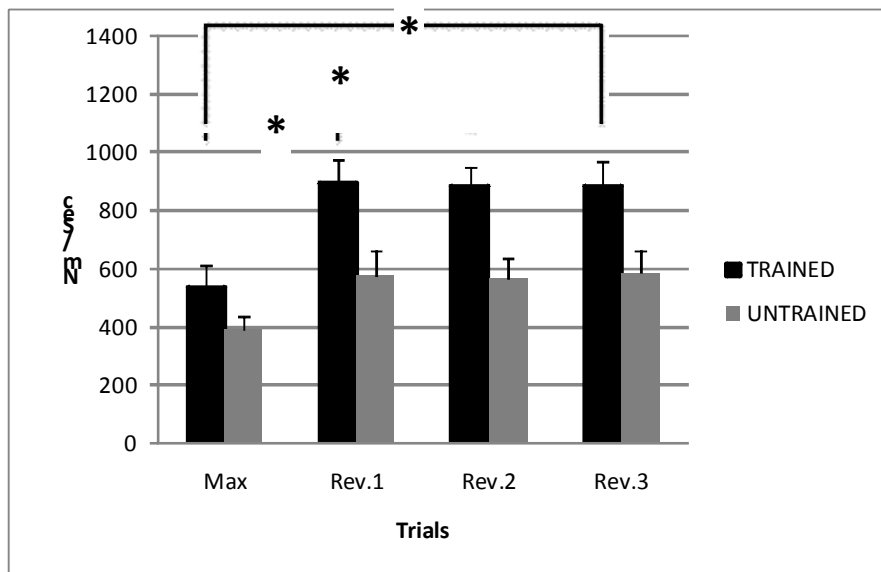


Figure 4. Reversal effect of RTD during the first 50msec of MIVC

For the 100 msec RTD no reversal effect was observed in both group ($p > 0.05$). A tendency for enhancement and higher values in all cases was observed in trained group compared with untrained one without being significant.

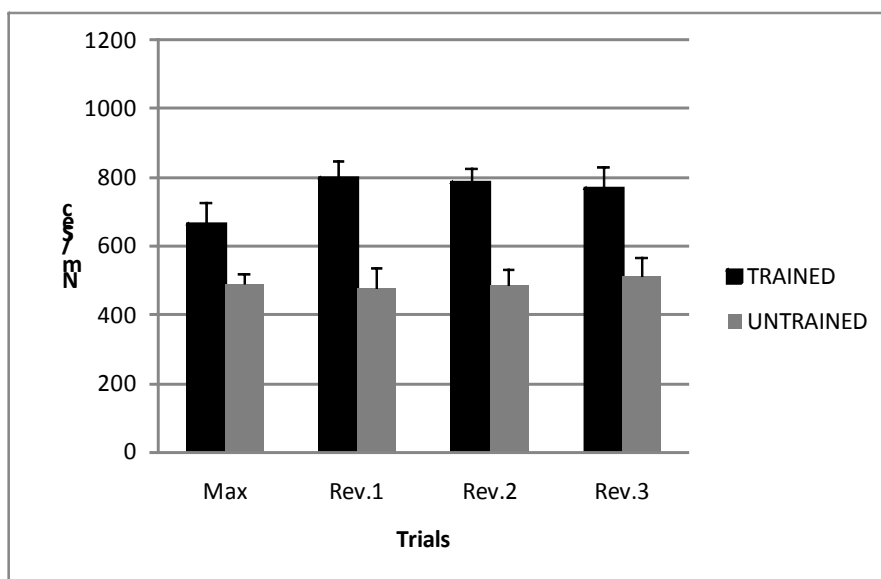


Figure 5. Reversal effect on RTD during the first 100 msec of MIVC

No reversal effect was observed for both of the two groups for the RTD during the first 200 msec ($p > 0.05$). However the values of the trained group were higher compared to untrained one but without been significant.

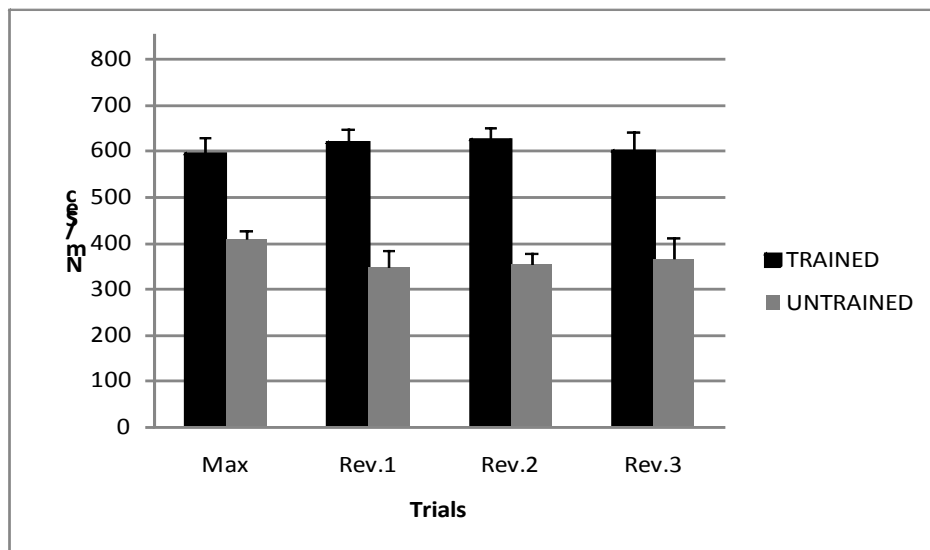


Figure 6. Reversal effect on RTD during the first 200 msec of MIVC

The statistical analysis showed that there are no statistically significant differences between efforts and groups (trained-untrained).

Discussion

The obtained results indicate that REV did not affect in RTD but observed a statistically significant difference in peak torque between the trained and untrained women. Regarding the rate of torque development differences were found between the efforts but not between groups. The effect of reversal on the torque are conflicting, since in other cases there was an increase of output torque (Kamimura, 2007; Kamimura et al., 2009), and in other cases not (Bohannon, 1985; Grabiner, 1994; Gabriele et al., 2001).

The differences in the results compared with those of previous research may be due:

- Using different protocols,
- Smaller sample compared with other investigators,
- Experiment on different samples.

However that found better results in the trained group, although not statistically significant, they should trouble us so to see if the phenomenon of reversal of antagonists can be used to implement new training protocols. The best results in the trained group probably due to the fact that trained individuals have practiced to be fast energy transfer in myotendon system during a movement. The detailed study of the phenomenon it is necessary to allow the understanding and the further practical application.

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