DROP JUMP TRAINING STIMULUS INDUCES DIFFERENT QUALITATIVE ADAPTATIONS ON THE ELECTROMYOGRAPHIC (EMG) PATTERN OF THE LEG EXTENSOR MUSCLES

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INTRODUCTION

For training purposes, it is relevant that reactive strength training could cause not only quantitative changes of the neuronal input to the muscle but also a qualitative shifting in the electromyographic patterns (Schmidtbleicher et al., 1988). Jumping technique can dramatically affect drop jump performance (Warren et al., 1995), which suggests that the quality of the training stimulus may also influence the neuromuscular control of drop jump exercises.

The present study was designed to investigate the changes in performance characteristics and in neuronal activation patterns, induced by different drop jump training stimulus.

METHODS

Thirteen healthy males were involved in an 8 weeks training program, followed by a detraining period o 4 weeks and a new training period of 4 additional weeks. The subjects exercised 3 to 4 times per week. They performed reactive DJ from their best drop height. All the training sessions were supervised. During the sessions of the first 4 weeks the subjects were informed on the flight time of each jump and a reactive jump of maximal effort with a short contact time were continuously requested by the supervisor. On the training sessions from week 4 to week 8 the supervisor only informed the subjects about the flight time of the jump. Finally, on the last 4 weeks the subjects were informed both on the flight and contact time of each jump. The testing procedures took place before and after each 4 weeks. The subjects performed squat jumps (SJ), conter-movement jumps (CMJ) and reactive drop jump (DJ) exercises from the heights of 25, 40, 55 and 70 cm. The vertical ground reaction forces, the angular displacement of the knee and ankle joints as well as the surface electromyograms (EMG) of the triceps surae muscles (GAS and SOL), vastus medialis (VM) and biceps femuris (BF) were recorded. Each jump was performed six times. Force, angle displacement and EMG signals, were averaged for each jumping condition. The EMGs were full-wave rectified and integrated (iEMG) over different functional phases (Dietz et al., 1979): Preactivation phase (PRE) (100ms before ground contact); Reflex Induced Activation phase (i.e. the activation phase from 40 ms to 120 ms after impact); Late EMG Response phase (LER) (activity from 120 ms until the end of contact).The significance of the differences were tested with Anova for repeated measures.

RESULTS

Table 1 summarises the results observed on the height of rise of the centre of gravity (HRCG) and contact time (CT) ratio, during the training process. The increase on the jump height/contact time ratio (JHCT) corresponds to the training periods where the subjects were continuously instructed to jump reactivly and received feedback information on the jump height and contact time of each individual drop jump. A decrease on the jump height/contact time ratio (JHCT) occurred when the feedback was only the jump height of the drop jumps.

Table 1- Mean and standard deviation of the jump height / contact time ratio (JH/CT), for drop jump exercises from 25 cm (DJ25), 40 cm (DJ40), 55 cm (DJ55) and 70 cm (DJ70), during the training process

	Week-0	Week-4	Week-8	Week-12	Week-16
DJ25	148±30	166±31	160±39	166±39	217±26
DJ40	149±37	161±32	159±46	170±39	213±28
DJ55	145±42	158±34	154±49	156±42	196±28
DJ70	134±39	139±31	142±49	141±46	181±35

On the last training period a significant negative correlation ($p<0.01$) was found between the changes on the iEMG of the RIA phase and the changes on the total contact time (figure 1).

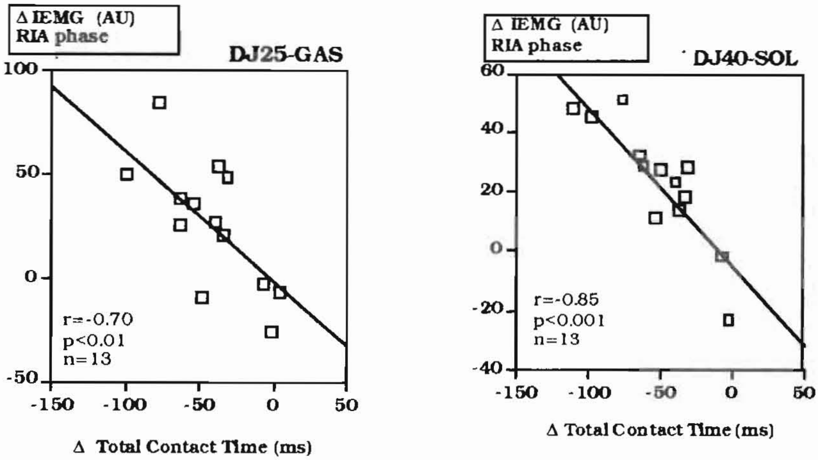

Figure 1. Relationships between changes in contact time and in iEMG of the RIA phase for gastrocnemius (GAS) and soleus (SOL) muscles in the drop jump from 25 cm (DJ25), and 40 cm (DJ40), on the last testing moment.

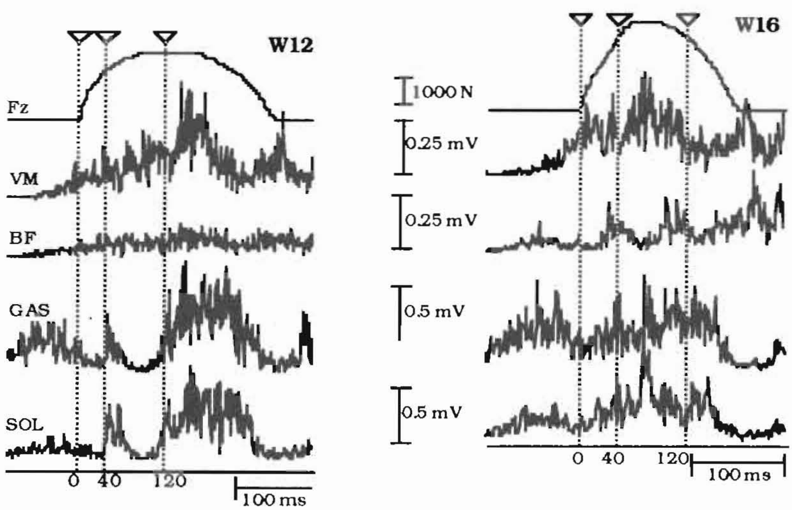

Figure 2. Average signals of force (Fz) and rectified EMG's of vastus medialis (VM), biceps femoris (BF), gastrocnemius (GAS) and soleos (SOL) muscles, of the drop jump from 25cm (DJ25) .On the left panel is the fourth (week 12) testing moment and on the right panel is the fifth (week 16)testing moment.

The increase on the JHCT ratio were followed by a qualitative shifting ($p<0.001$) in the EMG-patterns toward an accented RIA-phase activation (figure 2). These results on the JHCT ratio were accompanied by an increase on the stretching velocity of the soleos muscle ($p<0.01$) and by a potentiation of the force response (p<0.01). These positive adaptations could not be observed when the JHCT ratio significantly decreased (week 8).

These results revealed that feedback on the jumping performance, produced clear differences on the biomechanics of the jump. Qualitative adaptations on the EMG pattern induced by a strength training program with drop jump exercises, are only observed if the jumping technique allows for a good jump height/contact time ratio. The correlation coefficients, between the Δ changes on the iEMG of the RIA phase and the Δ changes on the total contact time, ranged from 0.70 and 0.85 (p<0.001), invites the interpretation that the positive changes on the RIA-iEMG of the GAS and SOL muscles can explain the reduction in the total contact time of the DJ in 49 to 72% (r^2=0.49 - r^2=0.72). Many other factors would have a positive influence on the changes in the contact time, but it seems unquestionable the role of the neural activation on this particular phase.

CONCLUSION

For these reasons, both the parameters (TCT and HRCG) should be used in training practice as important tools for the rapid diagnose of the quality of the training stimulus. A decrease of the ratio will mean a degradation of the quality of the stretch-shortening cycle, requiring a change on the jumping technique and/or a longer rest interval between the sets and/or a reduction of the total volume of drop jump training.

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