AN ELECTROMYOGRAPHIC COMPARISON BETWEEN THE SQUAT IN A DECLINE BOARD AND IN A FLAT SURFACE WITH DIFFERENT OVERLOADS

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The purpose of this study was to compare the myoelectric activity among the squat on a decline (DS) and a flat surface (SS). Eight individuals completed 15 RM tests for both squats in different days. They did three sets of the situation of the day test with different overloads (no overload [NO], 30% 15 RM [30] and 60% 15 RM [60]). An increase was verified in the activity from standard to decline squat in *Rectus Femoris* (DS NO= 64,8%; DS 30= 66,8%; DS 60= 70%; SS NO= 33,7%; SS 30= 37,6%; SS 60= 42,8%), *Vastus Lateralis* (DS NO= 75,4%; DS 30= 80,9%; DS 60= 81,5%; SS NO= 51,9%; SS 30= 58,9%; SS 60=62,9%), *Gastrocnemius Medialis* (DS NO= 13,1%; DS 30= 14,3%; DS 60= 14,2%; SS NO= 9,4%; SS 30= 10,2%; SS 60= 10,6%) but not to Hamstrings. We also did not find differences in myoelectric activation with the use of a backpack, in either squat, with tested overloads.

KEY-WORDS: biomechanics, decline squat, EMG, jumper's knee, rehabilitation.

INTRODUCTION:

The prevalence of patellar tendinopathy is high in sports characterized by elevated demands of speed and power in knee extensors, between 40% to 50% of the cases (Lian, Engebretsen & Bahr, 2005).

The eccentric squat on a 25º decline board has been lately appointed to be the "gold standard" in the rehabilitation management of this injury (Visnes & Bahr, 2007). Several studies have used this new methodology, presenting positive results compared to concentric training (Jonsson & Alfredson, 2005), standard squat (Purdam *et al*., 2004), pulsed ultrasound and transverse friction (Stasinopoulos & Stasinopoulos, 2004) and even surgery (Bahr *et al*., 2006).

However, only two studies, of our knowledge, examined biomechanical variables related to the proposal of higher efficacy of this treatment. Kongsgaard *et al*. (2006) demonstrated an increase in the decline squat in the load and strain of the patellar tendon. These data allow some explanations for the findings related to the efficacy of this training for athletes with patellar tendinopathy. Nevertheless, this study did not test those variables with additional weight. Thus, it is not known if any alteration in the myoelectric activity could occur in other conditions.

Zwerver, Steven and Hof (2007) found an increase in knee torque (40%) in squats with boards declined above 15º. When the squat was executed with an overload (10 kg), the knee torque was higher than without extra overloads. The patello-femoral and the patellar tendon forces increased with the inclination increment. It was verified that in angles over 60º of knee flexion, the patello-femoral force increases more than patellar tendon force. In conclusion the authors proposed the use of backpack weights instead of higher range of motion to increase the load in the patellar tendon.

It's already known that the use of progressive overloads is an important way to prepare tendons to absorb high mechanical loads (Visnes & Bahr, 2007). However, there are no studies comparing the muscular activation between the squat in a decline and flat surface with different intensities of backpack weights.

Due to the lack of scientific evidences, the aim of this study was to compare the myoelectric activity of muscles *Rectus Femoris, Vastus Lateralis*, Hamstrings and *Gastrocnemius Medialis* between the 25º decline squat and the standard squat, with no extra overload, 30% and 60% of 15 RM.

METHOD:

Data Collection: A sample of six men (28,5 ± 10 years, 75,5 ±12 kg) and two women (22 years, 61,1 ± 11 kg) was selected by convenience to participate in the study and gave their informed consent. None of them had signs or symptoms of injury in the lower limb nor a score < 90 in the VISA (Victorian Institute Sport Assessment) questionnaire (Visentini *et al., 1998)*.

Tests were performed in 2 days, with a minimum interval of 72 hours. A 15 maximum repetitions (15 RM) was stipulated to each participant, in the exercise of standard unilateral squat **(SS)** and 25º decline unilateral squat **(DS)**, both with a displacement of 90º. Afterwards, three sets of 15 repetitions were executed in the same condition of the tests, being one with no overload **(NO)**, one with 30% of 15 RM **(30)** and another one with 60% of 15 RM **(60)**. The order of execution was randomized. The eccentric phase was performed only with the dominant leg and the concentric with both legs. The rest between the test of 15 RM and the first set was 15 minutes and between the sets was 5 minutes. The overload was added in a backpack, according to Purdam *et al.* (2004).

To ensure that full range of motion (ROM) was reached by all, subjects received sensorial and oral feedback when the knee joint was at 90º of flexion. Velocity of each repetition was controlled by a metronome (Qwiktime) at a frequency rate of 1 Hz (45 degrees/sec).

Synchronous sampling of electrogoniometer and electromyography (EMG) (Biopac Systems Inc) were performed at a sample rate of 2000 Hz. Electrogoniometer (TSD 130B, Biopac Systems Inc) was positioned at the dominant knee of each subject and calibration samplings were obtained at 0º and 90º, according to MP100 System Guide (Biopac Systems Inc).

Surface electrodes of Ag/AgCl were positioned on the muscles *Rectus Femoris* (RF), *Vastus Lateralis* (VL), Hamstrings (HS) and *Gastrocnemius Medialis* (GM), according to Cram, Kasman and Holtz (1998) designation to bipolar EMG. The signal was filtered using a band pass (10-500 Hz) and a RMS value was obtained between 60° and the final position, in the eccentric (downward) phase, as a mean of the 15 repetitions RMS. This value was normalized using as a reference the greater mean RMS value gotten in two maximal voluntary isometric contractions (MVIC).

Data Analysis: Kolmogorov-Smirnov test was used to verify the normality of the data. Repeated Measures ANOVA and post hoc Tuckey's test ($p<0,05$) were used to estimate the level of significance of the differences among the six situations studied. The statistical package GraphPad Prim® (Version 4.01) was used for the data analysis

RESULTS:

The data were considered normal, according to Kolmogorov-Smirnov test ($\alpha=0,05$).

There were no statistical differences ($p>0,05$) in *Rectus Femoris* and *Vastus Lateralis* activity between DS NO x DS 30 x DS 60, neither between SS NO x SS 30 x SS 60 . Increases occurred in all others situations (Figure 1).

There were no statistical differences in activation of Hamstrings for all six situations (DS NO = 8,1%; DS 30= 8,4%; DS 60= 8,6%; SS NO= 9,9%; SS 30=8,3%; SS 60= 8,6%) ($p>0,05$).

Gastrocnemius Medialis activity increased ($p<0,05$) for SS NO (9,4%) x DS 30 (14,3%) and SS NO (9,4%) x DS 60 (14,2%). In the others situations there were no statistical differences (DS NO= 13,1%; SS 30= 10,2%; SS 60= 10,6%) ($p>0,05$).

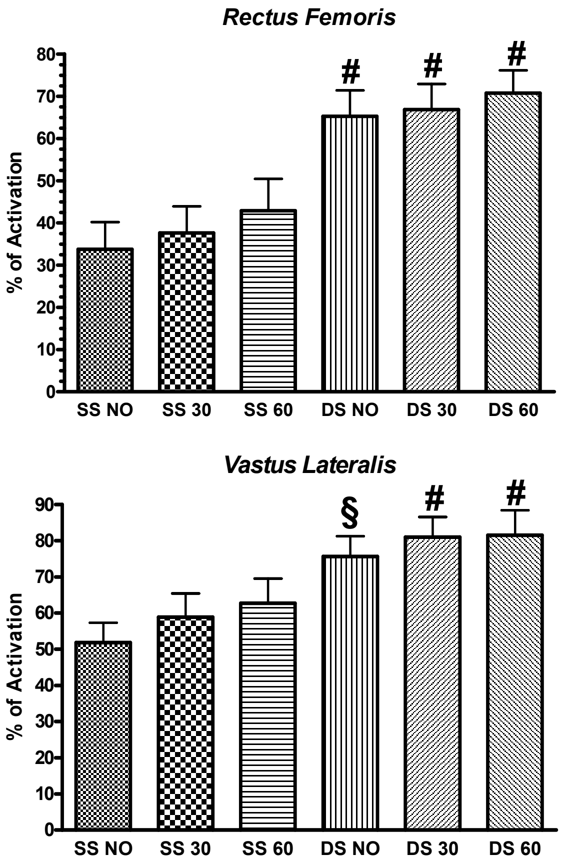

Figure 1: *Rectus Femoris* (left) *and Vastus Lateralis* (right) activity (#: significantly greater than SS NO, SS 30 and SS 60, p<0,001; **§**: significantly greater than SS NO [p<0,001], SS 30 [p<0,01] and SS 60 [p<0,05]).

DISCUSSION:

Eccentric single leg squat on a 25º decline board has being used as a rehabilitation management in the treatment of patellar tendinopathy in athletes of different sports. Although few studies examined this new methodology, almost all of them found positive results. Nevertheless, some confounding variables were not controlled and their influence was not investigated. One of them is the overload used with the improvement of treatment. All the prospective studies done with this methodology (Purdam *et al.*, 2004; Stasinopoulos & Stasinopoulos; 2004; Jonsson & Alfredson, 2005) proposed the use of a backpack with weights to increase the load in the patellar tendon. In these studies, they used an absolute overload (5kg, progressing to 10 kg).

However, in the consulted literature, only one study was done with the purpose to examine the influence of weights (Zwerver, Bredweg & Hof; 2007), nevertheless the focus was the load on this tendon. Although the load increases, the authors used an absolute overload (10kg), not a relative (%) one. This may have influenced the results, in regards to individuals differences.

According to Wilson *et al* (1993), the optimal overload to enhance power in squat must be in the range of 30% to 50% of 1RM. Fleck and Kraemer (2003) proposed that 15 RM is about 60% 1RM. So, the overload used in our study was in the range of 18% and 36% of 1RM. We supposed that this overload should be safe in the chronic rehabilitation phase of a tendinopathy.

Due to the lack of investigations about the myoelectric activity of the SS and DS with different intensities, we could not compare all of our results. Nevertheless, concerning the activation between DS NO and SS NO, we are in agreement with the study of Kongsgaard *et al* (2006), regarding the RF and VL activation.

The myoelectric activation of GM found is also in agreement with the Kongsgaard *et al* (2006). Between the SS NO and DS NO we found no statistical differences. However, there were differences ($p<0,05$) between the SS NO and DS 30; SS NO and DS 60.

Cram, Kasman and Holtz (1998) proposed that the HS electrode placement refers to *Semitendinosus* and *Semimembranaceous* activity. Thus, once again, our results are in agreement with Kongsgaard *et al.* (2006). Besides the low activation of these muscles, there were no differences among the two squats in any of the six situations.

We also found no statistical differences ($p>0,05$) with the use of a backpack among the three intensities tested (SS NO x SS 30 x SS 60 and DS NO x DS 30 x DS 60) for the knee extensors. However, the inexperience of all the subjects in the exercises and the low sample could have influenced our results.

Although we didn't find significant differences in myoelectric activity of knee extensors (DS NO x DS 30 x DS 60 and SS NO x SS 30 x SS 60), there was a trend of increase in these muscles. This fact could be related with a higher knee torque found in the study of Zwerver, Bredweg and Hof (2007). Moreover, it's acceptable that a higher torque can be produced even in the absence of differences of myoelectric activity (De Luca, 1997).

Due to our findings, we propose that studies with subjects trained in both squats and also with higher intensities and greater numbers of participants should be done in order to determine the real interference of these variables in the activation of the muscles tested.

CONCLUSION:

The results suggest that the use of weights in a backpack (30% and 60% 15 RM) does not significantly increase the activation of *Vastus Lateralis, Rectus Femoris*, Hamstrings and *Gastrocnemius Medialis*. Comparing the standard squat with the decline one, we observed a statistically significant increase in Quadriceps activation. Thus, this kind of exercise might be indicated when it's desirable to increase the knee extensors load, regarding the sports rehabilitation management.

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