THE USE OF A PRE-ACTIVATION EXERCISE FOR THE HAMSTRINGS TO OPTIMISE THE AMOUNT OF MUSCLE ACTIVITY PRESENT WITHIN A NORDIC HAMSTRING CURL

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The purpose of this study was to examine the effect of a pre activation exercise of the hamstring muscles on muscle activation during the Nordic curl. 8 male participants performed a set of Nordic Curls following a single leg Romanian deadlift using a theraband. Peak EMG data was analysed for each of the three hamstring muscles. Results show that there was a significant difference ($p=0.012$) in peak EMG muscle activity of the semitendinosus following activation compared to a control trial. There were no changes in peak EMG muscle activity of biceps femoris and semimembranosus. Use of a pre activation technique such as a theraband single leg Romanian deadlift can increase the peak activity in the Nordic curl and so should be performed first as a preventative measure in hamstring injuries.

KEY WORDS: Hamstring, Nordic curl, RDL, EMG

INTRODUCTION: The main concentric function of the hamstrings muscles is to cause flexion at the knee joint, with the main eccentric function being the deceleration of knee extension. Therefore, the hamstrings play a large role in basic movements used across sport, such as running and jumping. As a result of being a muscle used in a variety of sporting movements, hamstring strains are one of the most commonly injured areas of soft tissue among athletes (Petersen & Hölmich, 2005). It has been shown that injuries to the hamstring group mainly occur as a result of maximal eccentric contractions and an underlying strength deficit (Bahr & Holme, 2003). In an effort to prevent hamstring injuries, the most common exercises used are those that are designed to improve the strength of the hamstring muscles. Examples of strengthening exercises for the hamstrings include leg curls, good mornings and Nordic curls. Out of these exercises, the Nordic curl has been shown to be the most effective in eliciting eccentric strength adaptations (Mjølsnes et al, 2004). A Nordic curl exercise involves leaning forward from a kneeling position whilst maintaining a straight line from the ear to the knee with the trunk remaining stiff throughout and a neutral spine. This challenges the hamstrings to delay the fall for as long as possible with the ankles maintained stationary on the floor hooking the feet under a fixed object. Once the fall can be delayed no longer, the participant falls down into a press up position to cushion the fall, with the hands landing outside shoulder width. Strengthening the hamstrings in an eccentric strength manner such as the Nordic curl is likely to result in a decreased potential for injury at this muscle group (Kaminski et al, 1998).

Muscle activation exercises aim to increase the amount of activity within a muscle before a follow-up 'main' exercise. If more of a muscle is active, more of the muscle fibres will be utilised during the following activity. If a larger amount of a muscle is contributing towards a movement, then this movement becomes more efficient (Behm et al., 2002). A muscle can be activated via the use of an exercise that works the target muscle group at a low intensity, before a follow up compound exercise. In terms of the hamstring, activity is maximized in a Romanian deadlift (RDL) compared to leg curls and good mornings. Therefore, those who seek to maximize activity in hamstring musculature pre-exercise should consider the use of the RDL (McAllister et al., 2014). EMG is a widely used and accepted technique to employ during examinations of muscle activation within lower body exercises (Caterisano et al., 2002; Paoli et al., 2009). If a muscle activation exercise (i.e. RDL) can increase the amount of the hamstring muscle fibres being used in the Nordic curl, then more of the muscle is liable to strength adaptations. This will in turn lead to the potential for greater eccentric strength adaptations within the hamstrings and further decrease the potential of injury occurring due

to underlying strength deficits. Overall, the use of a muscle activation exercise has the potential to enhance the effectiveness of the Nordic curl in its ability to eccentrically strengthen the hamstrings. The aim of this study was to examine the effect of the inclusion of a preactivation exercise in a warm up on the muscle activity in the three hamstring muscles during a subsequent Nordic hamstring curl.

METHODS: 8 healthy male participants (20.8±0.83 years, 1.78±0.04 m, 80.01±14.9 kg) volunteered to complete the randomised repeated measures study. Participants attended a total of 3 sessions (1 x familiarisation, 1 x Nordic exercise with warm up only, 1 x Nordic exercise with warm up and muscle activation exercise). At least 2 hours were left between each session as 2 hours of recovery time is suitable for muscle activity to return to a baseline level. Activity at the measured muscle sites (semitendinosus, semimembranosus, and biceps femoris) was collected via EMG (Biometrics Ltd., UK) from the 2 trials under the different pre-exercise conditions. This was conducted in a randomised order. The electrodes were removed between tests. However, the location was identified with eyeliner to ensure that the electrodes were replaced in the exact same location for the subsequent trial. Resistant bands have been proven effective at increasing muscle activity (Hintermeister et al., 1996), and were used to provide resistance in the RDLs. Previous research using these bands suggested that exercises incorporating elastic resistance effectively activated both the targeted muscle and surrounding musculature. The movement speed for each Nordic curl exercise was carried out at a moderate movement velocity in a controlled and consistent manner using a metronome; a 4 second eccentric phase as has been shown effective (Headley et al, 2011).

Three electrodes were placed on the hamstring muscle of the dominant leg. SENIAM guidelines were followed. A reference electrode was placed on the C7 location of the spine. The EMG data was post processed using Datalink management and analysis software (Biometrics Ltd., UK). A differential technique was performed to reduce cross-talk of the EMG signal. The Raw EMG signal was processed in the time domain by computing the root mean square (RMS) value of the rectified signal, and then filtered as appropriate. The peak RMS data was calculated during the eccentric phase of the Nordic exercise movement. The EMG signal was normalised to a maximum voluntary contraction (MVC) of the hamstring which was gathered in the familiarisation session. All values exhibited by each participant in the trials are expressed as a percentage of MVC value. Data were statistically analysed using IBM SPSS 22.0 for Windows (SPSS Inc., Chicago, IL.). Checks that data are normally distributed and parametric were made using the Shapiro-Wilk test. Furthermore, a Paired samples T-test was used to determine whether there were any significant differences in muscle activity output between the measured muscles in the two different exercise conditions. Effect sizes were calculated using Cohens D.

RESULTS: There is an increase in mean peak EMG activity in all three muscles following the pre-activation exercise. The response of each of the eight participants can be seen in Figure 1. A significant difference was found in the semitendinosus (p= 0.012, d = 0.383). Individual differences in response to the activation exercise and a large variation in %MVC between participants (Figure 2) results in no significant differences were found between the non-activated and activated conditions in the biceps femoris and the semimembranosus ($p>0.05$).

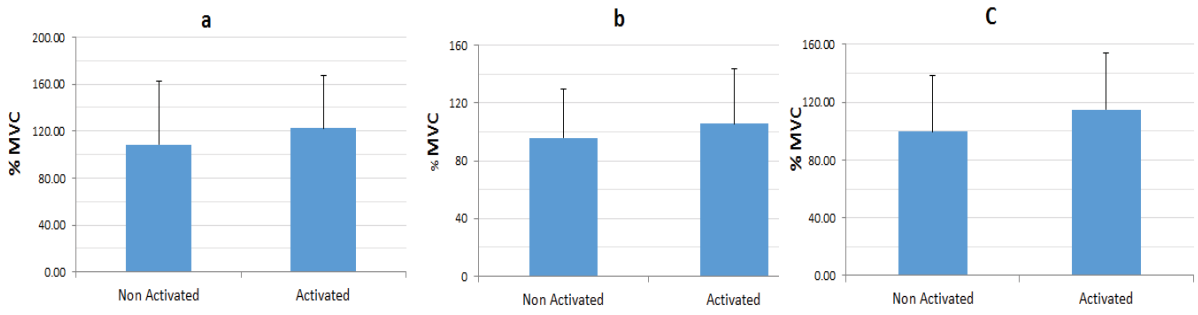

Figure 1: Group Peak EMG activity in each of the three hamstring muscles as a % of MVC
A – Biceps Femoris B- Semitendinosus C- Semimembranosus

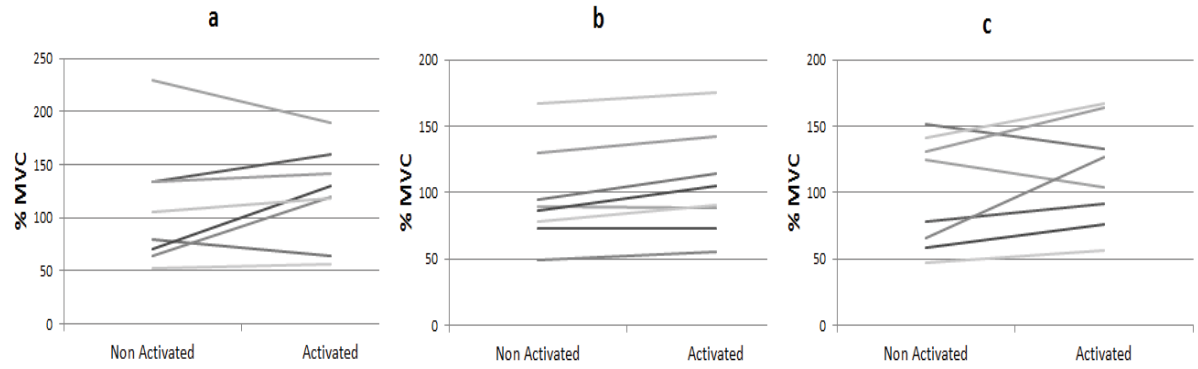

Figure 2: Individual Peak EMG activity in each of the three hamstring muscles as a % of MVC
A – Biceps Femoris B- Semitendinosus C- Semimembranosus

DISCUSSION: The results of this study have provided unique and important insights into understanding the role of pre activation effect of performing an RDL prior to a Nordic Hamstring Curl. There was a significant difference in the peak EMG activity in the semitendinosus muscle between the activated and non-activated trails. This indicates that pre activation can play a role in improving the muscle activity in a subsequent targeted exercise. There is a large inter participant effect of the pre-activation. In both the biceps femoris and the semimembranosus 6 of the 8 participant increase the muscle activation following the RDL exercise. This indicates the despite the lack of a significant difference between conditions individuals may increase their peak EMG activity. Considering the Nordic curl is a bodyweight only resistance exercise, this highlights the demand that this exercise places on the hamstring muscles. The demand would be further increased by adding a resistance load to the exercise.

The effect on medial and lateral hamstrings has been examined previously (Bourne et al, 2016). In a study of ten hamstring exercises they found the largest biceps femoris/medial hamstring EMG ratio occurred in the 45° hip-extension exercise; the lowest was in the Nordic curl and bent-knee bridge exercises. This corresponds with the raw data from this study with further analyses required to determine the extent of this reliance on the medial hamstring muscles during the Nordic curl. Nordic curls have been identified as a method of prevention of hamstring strains in elite soccer (Arnason et al., 2008). Their study indicated that an eccentric strength training program with Nordic hamstring curls could reduce the incidence of hamstring strains in elite soccer players. The current study highlights the importance of peak EMG recruitment and the impact that it may have on this research. To interpret the results of this study, it is important to consider that various EMG techniques measure different aspects of muscle activity. Further research will examine total EMG activity during the 4 second trial and will also examine if stabilising muscles such as the gluteus medius and gastrocnemius are also impacted by a pre activation using an RDL. Pre exhaustion exercises have been

used to elicit changes in EMG activity (Augustsson et al, 2003). In addition previous research has examined the use of whole body vibration on EMG activity during the exercise (Roelants et al.,2006). However, pre activation exercises have not been used in a similar manner.

CONCLUSION: This study highlights the potential of the RDL as a pre activation exercise to improve the effectiveness of a Nordic Curl exercise. The Nordic Curl exercise has previously been shown to reduce the incidence of hamstring strains. The use of the RDL in a warm up protocol may accentuate these benefits. The use of a pre activation exercise prior to completion of a Nordic curl has not been previously examined. This study provides the link between pre activation and injury prevention of the hamstrings via the medium of the Nordic curl exercise.

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