33 - SHOULDER EMG ACTIVITY DURING ABDUCTION WITH AND WITHOUT EXTERNAL ROTATION

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INTRODUCTION

Resisted training presents many variations and possibilities. The exercise prescriptions in gym ambience were chosen generally by empirical instructor knowledge and this can to difficult the training plan development. Many exercises can be used to develop the same muscle group, thus, exercises must be more indicated to each specific situation (ROCHA-JÚNIOR, 2007). The glen humeral joint is covered by deltoid muscle (BRADLEY, e TIBONE, 1991) Due to big joint range of motion, deltoid muscle portions activation during arm abduction are distinct (DAVID et al, 2000). Electromyography (EMG) has been a used an accurate tool to determine muscle activation. In shoulder, has been used for many applications such therapy (STEENBRINK et al, 2010) kinesiology studies (HODDER e KEIR, 2012) and sport (ILLYÉS e KISS, 2005), this tool can be an important method to assess the variations in resistance exercise, thus improving the training effectiveness. Reinold, et al (2004) evaluated Supraespinal, infraespinal, teres minor, anterior deltoid (AD) and posterior deltoid (PD) during rehabilitation exercises and observed different activation patterns between exercises between them. Shoulder abduction exercises have shown that AD muscle activation was higher compared to the PD when loads or unloaded in the hands (ANTONY and KEIR, 2009) or changing in speed of execution (ALPERT, et al. 2000). Studies have shown that abduction and development exercises, recruits more AD muscle than PD on these two types of exercises for the deltoid muscle (SILVEIRA et al. 2011). Saeterbakken and Fimland (2013) observed the effects of body position on two types of exercises in deltoid muscle, but without evaluation of shoulder accessory movements. The internal and external rotation of the shoulder seems to affect the deltoid activity during shoulder abduction to 90 ° (LUI et al, 1997). Shoulder abduction exercise is commonly used in gyms and prescribed for the deltoid (lateral) muscle, however, the participation of other portions (AD and PD) on the neutral and external rotation of the humerus could modify the activation of these muscles. Thus, the aim of this study was to evaluate the activity of AD and PD muscles during shoulder abduction exercise with and without external rotation of the shoulder in trained individuals.

METHODOLOGY

Seven males with age 22 (± 2.58) years, body mass 75.8 (± 6.04) kg, height 175.2 (± 5, 3) cm and strength training time 2.38 (± 1.4) years. All subjects had experience performing the exercises. The differences between shoulder muscle activation in abduction exercise, the deltoid muscle (AD and PD) was measured during the execution in shoulder neutral and external rotation. The load was standardized with a 8kg barbell simultaneously by both members, and the EMG assessment was only in the right shoulder. This load represented around 70% of 1RM. The speed of the movement was controlled by a metronome with rate of 120 bpm. The data was recorded 10 seconds of movement execution which comprised two thirds of the time after the beginning contractions execution. Subjects performed shoulder abduction to 90 ° with neutral position (olecranon rear-facing) and After five minutes of rest they performed shoulder external rotation (olecranon facing down) in 5 repetitions for each exercise. To collect the EMG data Miotool/Miotec (Porto Alegre, Brazil) four channels was used. Medi Trace 100 Kendal Electrodes (Mansfield, MA, CAN), bipolar with active surface electrodes Ag / AgCl. The electrodes were placed parallel to the muscle fibers of the deltoid anterior and posterior and reference electrode was placed on spine process of 7th cervical vertebrae, following the recommendations by Hermens, et al (1990). The identification of anatomical landmarks and electrode placement were performed by the same researcher. Electrodes were placed in the right hemisphere (dominant subjects) by adhesives after shaving and cleaning with alcohol 96%. The EMG was obtained with a gain of 1000Hz and raw signal subjected to a band-pass filter (20-450Hz). To evaluate the differences between muscle activation was used mean values of Root Mean Square (RMS) for statistical analysis data.

RESULTS AND DISCUSSION

Table 1 shows the activation values of (RMS) to the muscles in both AD and PD types of exercises.

Tabela 1. Descriptive statistics (mean ± standard deviation) between shoulder muscles in two positions.

N=7	No Rotation		External Rotation	
Muscle	PD	AD	PD	AD
RMS (μV)	177,89±33,3	269,09±123,91	115,29±49,34	221,26±70,75
T-Test	p= 0,0006ǂ		p= 0,03ǂ	

ǂ statistical differences.

The t test showed significant differences in AD muscle activation in relation to PD. With external rotation (Figure 1), the results also showed differences. Figure 2 shows the muscle electromyography signals from this study.

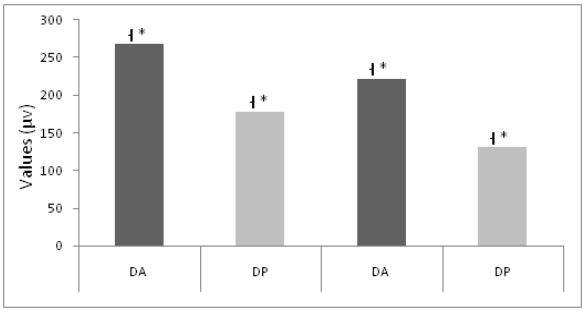

Figure 1 Results of the RMS values for average ŧ Significant difference between AD and PD with and without shoulder rotation, * Significant difference between no rotation and shoulder rotation.

The results also showed that AD and PD were less effective when there was arm external rotation decreased 35% and 17% respectively. The greater activation of DA disagrees with findings for this portion of (SILVEIRA et al, 2010) but agrees with studies by Liu et al (1997) where the DA moment arm is larger (1.5 cm) when shoulder is in external rotation than neutral position, what can influence the decrease muscle action on this position. DA greater activation during shoulder abduction were also reported by several studies (ANTONY & KEIR, 2010; WICKHAM et al, 2010; HODDER & KEIR, 2012). This electrical potential decrease can be related to the antagonist rotator cuff action against deltoid muscle turning these muscles less effective through reciprocal inhibition because the the rotator cuff is a shoulder stabilizer, and during abduction increases significantly when there is a shoulder external rotation (ALPERT et al. 2000). Another hypothesis is that the rotation would increase the distance from the AD regarding the origin and at the same time would approach the origin and insertion of the PD thus diminishing their effectiveness.

We conclude that muscle exercises AD and PD exercise abduction without rotation of the shoulder would be the best to optimize these muscles.

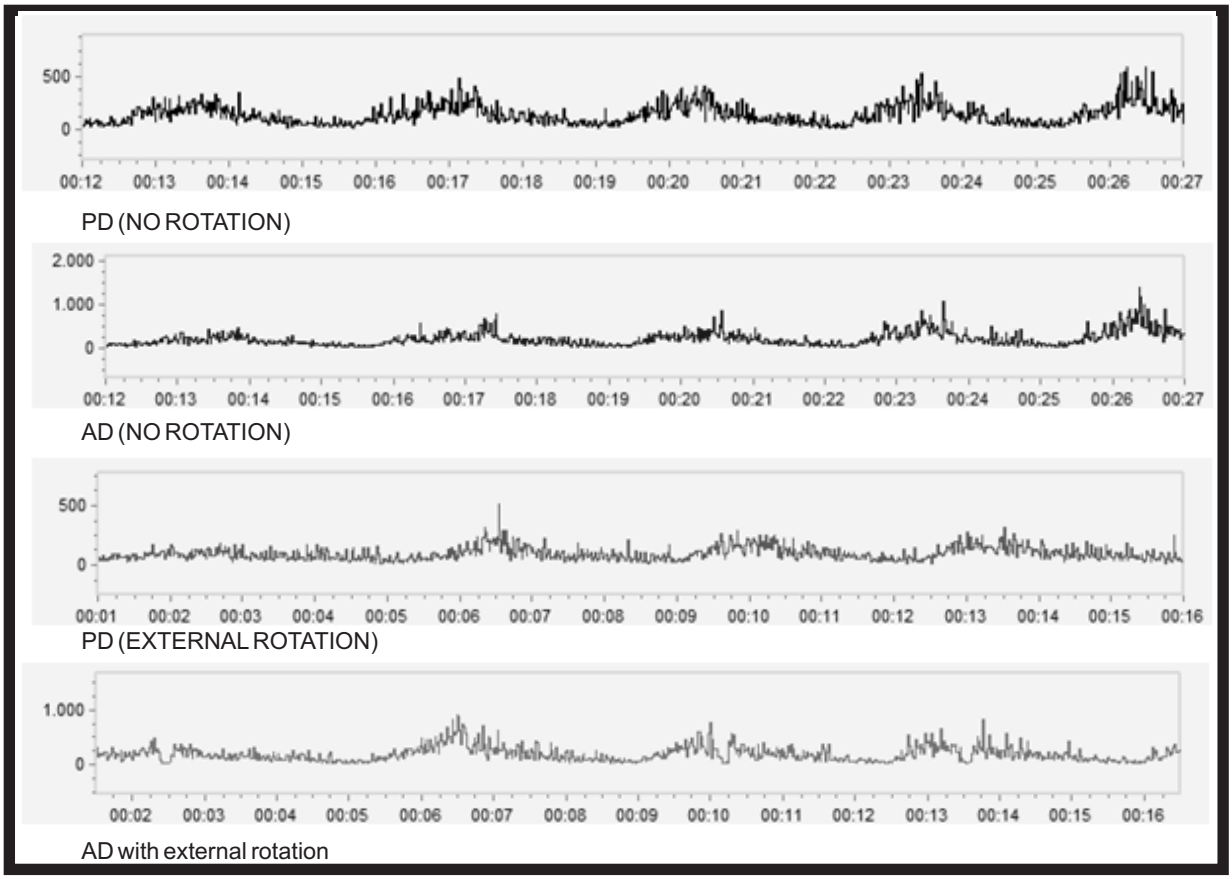

Figure 2: Muscles EMG on this study. Signals in Root Mean Square.

REFERENCES

ALPERT, S. W.; PINK, M. M. ; JOBE, F. W.; McMAHON, P. J. MATHIYAKOM, W. Electromyographic analysis of deltoid and rotator cuff function under varying loads and speeds. Journal of shoulder and elbow surgery. January/ February, p. 47-58. 2000.

ANTONY, N.; KEIR, P. Effects of posture, movement and hand load on shoulder muscle activity. Journal of Electromyography and Kinesiology 20, p. 191–198. 2010.

BRADLEY, J.P.; TIBONE, J.E. Electromyographic analysis of muscle action about the shoulder. Clin Sports Med.;10:789-805, 1991.

DAVID, G.; MAGAREY, M.; JONES M.; DVIR, Z.; TÜRKER,K.; SHARPE, M. EMG and strength correlates of selected shoulder muscles during rotations of the glenohumeral joint. Clinical Biomechanics. 15, p. 95-102. 2000.

HERMENS, H., FRERIKS, B., DISSELHORST-KLUG, C., RAU, G. Development of recommendations for SEMG sensors and sensor placement procedures. Journal of Electromyography and Kinesiology. v.10, p. 361-374, 2000.

HODDER, J.; KEIR, P. Targeted gripping reduces shoulder muscle activity and variability. Journal of Electromyography and Kinesiology. 22, p. 186–190. 2012.

ILLYÉS, A.; KISS, R. Shoulder muscle activity during pushing, pulling, elevation and overhead throw. Journal of Electromyography and Kinesiology 15, p. 282–289. 2005.

LIU, J.; HUGHES, R. E.; SMUTZ, W. P., NIEBUR, G.; NAN-AN, K. Roles of deltoid and rotator cuff muscles in shoulder elevation. Clinical biomechanics Vol 12 (1) pp.32-38. 1997.

MALAGA, G.A; JENP, Y.; GROWNEY, E.S.; AN, K. EMG Analysis of shoulder positioning in testing and Strenghening the supraspinatus. Medicine and science in Sport and Exercise. p. 661- 664. 1996.

REINOLD, M. M.; WILK, K. E., FLEISIG, G.S.; ZHENG, N.; STEVEN W.; BARRENTINE, S.W.; CHMIELEWSKI,T.; CODY, R.; JAMESON, G.; ANDREWS, J. Electromyographic Analysis of the Rotator Cuff and Deltoid Musculature During Common Shoulder External Rotation Exercises. J Orthop Sports Phys Ther. Volume 34 Number 7 July 2004.

ROCHA JÚNIOR, V.; GENTIL, P.; OLIVEIRA, E.; CARMO, J. Comparação entre a atividade EMG do peitoral maior, deltóide anterior e tríceps braquial durante os exercícios supino reto e crucifixo. Rev Bras Med Esporte. Vol. 13, Nº 1 – Jan/Fev, 2007.

SAETERBAKKEN, A.; FIMLAND, M. Effects of Body Position and Loading Modality on Muscle Activity and Strength in Shoulder Presses. Journal of Strength & Conditioning Research. 27(7):1824-1831, July 2013.

SILVEIRA, F.; FRANKE, R.; RODRIGUES, R.; BOTTON, C.; PINTO, R.; LIMA, C. Diferença da atividade eletromiográfica do deltóide nos exercícios elevação lateral e meio desenvolvimento. XII Salão de Iniciação Científica – PUCRS, 03 a 07 de outubro de 2011.

STEENBRINK, F.; MESKERS, C.; NELISSEN, R.; de GROOT, j. The relation between increased deltoid activation and adductor muscle. activation due to glenohumeral cuff tears. Journal of Biomechanics 43, p. 2049–2054. 2010.

WICKHAM, J.; PIZZARI. T.; STANSFELD, K.; BURNSIDE, A.; WATSON, L. Quantifying 'normal' shoulder muscle activity during abduction. Journal of Electromyography and Kinesiology 20, p. 212–222. 2010.

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SHOULDER EMG ACTIVITY DURING ABDUCTION WITH AND WITHOU EXTERNAL ROTATION

ABSTRACT

The aim of this study was to investigate if external rotation of the shoulder affects the deltoid in abduction exercise. Seven healthy men with experience in resistance training were evaluated in muscles anterior deltoid (AD) and posterior deltoid (PD) by surface electromyography. The subjects performed shoulder abduction to 90° in the frontal plane with elbow extension, with and without external rotation of the shoulder. All individuals performing the movement with the same load (one halter 8kg) right shoulder was used to obtain the data. Were used bipolar surface electrodes (distance 20 mm) and the data recorded by Miotool 400®. The electrodes were placed on the AD and PD and the ground reference electrode was placed on the spine of the 7th cervical vertebra. After raw data acquisition a bandpass filter (20-450 Hz) was applied and the values of Root Mean Square (RMS) were used for statistical analysis. The T-test showed significant differences in muscle AD with and without rotation and PD as well. greater activation of DA during shoulder abduction were also reported by several studies. CA and PA showed less activation in external rotation (35% and 17 %) respectively. This probably happened because rotator cuff acts as an antagonist of the deltoid muscle and may become less effective AD and PD by reciprocal inhibition. The external rotation would increase the distance between the origin and insertion of DA and decreasing distance between the origin and insertion of PD. We concluded that for AD and PD muscles exercise abduction without rotation of the shoulder would be the best to optimize these muscles.

KEYWORDS: EMG, Shoulder, Fitness.

EMG ACTIVITÉ LORS ABDUCTION DE L'ÉPAULE AVEC ET SANS ROTATION EXTERNE

RÉSUMÉ

Le but de cette étude était de déterminer si la rotation externe de l'épaule affecte le deltoïde en exercice de l'enlèvement. Sept hommes en bonne santé ayant une expérience dans la formation de résistance ont été évalués dans les muscles deltoïde antérieur (DA) et postérieur du deltoïde (DP) par électromyographie de surface, les sujets ont effectué abduction de l'épaule à 90 ° dans le plan frontal avec l'extension du coude, avec et sans rotation externe de l'épaule. Toutes les personnes effectuant le mouvement avec la même charge (un licol 8 kg) épaule droite seul objectif a été utilisée pour obtenir les données. Ont été utilisés des électrodes de surface bipolaires (distance de 20 mm) et les données enregistrées par l'appareil Miotool 400 ®. Les électrodes ont été placées sur le CA et PA, et l'électrode de référence au sol a été placé sur la colonne vertébrale de la septième vertèbre cervicale. Après l'acquisition des données brutes, un filtre passe-bande (20-450 Hz) a été appliquée et les valeurs de Root Mean Square (RMS) ont été utilisés pour l'analyse statistique. Le T- test a montré des différences significatives dans le muscle DA avec et sans rotation et DP ainsi. Résultats supérieurs activation de DA durant l'enlèvement d' épaule ont également été signalés par plusieurs études. CA et PA ont montré moins d'activation en rotation externe (35 % et 17%), respectivement. C'est probablement ce qui s'est passé parce que la coiffe des rotateurs agit comme un antagoniste du muscle deltoïde et peut devenir moins efficace DA et DP par inhibition réciproque. La rotation externe serait d'augmenter la distance entre l'origine et l'insertion de DA et de diminuer la distance entre l'origine et l'insertion de DP. Nous avons conclu que pour l'DA et DP muscles exercice enlèvement sans rotation de l'épaule serait la meilleure pour optimiser ces muscles.

MOTS-CLÉS: EMG, épaule, Fitness.

ACTIVIDAD ELECTROMIOGRAFICA DE ABDUCION DEL HOMBRO CON Y SIN ROTACIÓN EXTERNA

RESUMEN

El objetivo de este estudio fue investigar si la rotación externa del hombro afecta el deltoides en ejercicio secuestro. Siete hombres sanos con experiencia en el entrenamiento de resistencia se evaluaron en los músculos deltoide anterior (DA) y posterior (DP) mediante electromiografía de superficie, los sujetos realizaron la abducción del hombro a 90 ° en el plano frontal con extensión del codo, con y sin rotación externa del hombro. Todas las personas que realizan el movimiento con la misma carga (un halter 8kg) hombro derecho único objetivo fue utilizado para obtener los datos. Se utilizaron electrodos de superficie bipolares (distancia de 20 mm) y los datos registrados por el aparato Miotool 400 ®. Los electrodos se colocan en el DA y DP, y el electrodo de referencia de tierra se colocó en la columna vertebral de la séptima vértebra cervical. Después de la adquisición de los datos en bruto, se aplicó un filtro de paso de banda (20-450 Hz) y los valores de Root Mean Square (RMS) se utilizaron para el análisis estadístico. El Teste-T mostró diferencias significativas en el músculo AD con y sin rotación y el DP también. Resultados de una mayor activación de DA durante la abducción del hombro también fueron reportados en varios estudios. DA y DP mostraron una menor activación de la rotación externa (35 % y 17 %) respectivamente. Esto ocurrió probablemente porque manguito de los rotadores actúa como un antagonista del músculo deltoides y puede llegar a ser menos DA y DP efectiva por la inhibición recíproca. La rotación externa aumentaría la distancia entre el origen y la inserción de DA y disminuir la distancia entre el origen y la inserción de la DP. Llegamos a la conclusión de que para DA y DP músculos ejercicio sin rotación del hombro sería la mejor forma de optimizar estos músculos.

PALABRAS – CLAVE: EMG, Ombro, Fitness

ATIVIDADE ELETROMIOGRAFICA DURANTE A ABDUÇÃO DE OMBRO COM E SEM ROTAÇÃO EXTERNA

RESUMO

O objetivo deste estudo foi investigar se a rotação externa do ombro afeta o músculo deltóide em exercício de abdução. Sete homens saudáveis com experiência em treino resistido foram avaliados nos músculos deltoide anterior (DA) e deltoide posterior (PD) via eletromiografia de superfície, os avaliados executavam a abdução do ombro até 90 ° no plano frontal, com extensão do cotovelo, com e sem a rotação externa do ombro. Todos os avaliados realizar o movimento com a mesma carga (uma halter de 8kg) só ombro direito objetivo foi utilizado para obter os dados. Foram usados eletrodos bipolares de superfície (distância de 20 mm) e os dados gravado pelo equipamento Miotool 400 ®. Os eletrodos foram posicionados sobre o DA e DP, e o eletrodo de referência terra foi colocado na espinha da vertebra cervical 7. Após a aquisição dos dados brutos, um filtro passa-banda (20-450 Hz) foi aplicado e os valores de Root Mean Square (RMS) foram utilizados para a análise estatística. O Teste-T mostrou diferenças significativas nos músculos AD com e sem rotação e PD também. Resultados de maior ativação do DA durante a abdução do ombro também foram relatados por vários estudos. DA e DP apresentaram menor ativação em rotação externa, (35% e 17%) respectivamente. Isso provavelmente aconteceria porque manguito rotador age como antagonista do músculo deltoide e podendo tornar DA e DP menos eficazes por inibição recíproca. A rotação externa aumentaria a distancia entre a origem e a inserção do DA e diminuindo distância entre a origem e a inserção do DP. Concluímos que para os músculos DA e DP o exercício de abdução sem rotação do ombro seriam os melhores para otimizar esses músculos.

PALAVRAS – CHAVES: EMG, Ombro, Fitness.