Dariusz KOMOROWSKI[1], Barbara MIKA[1]

[1]Silesian University of Technology, Faculty of Biomedical Engineering, Roosevelt str. 40, 41-800 Zabrze, Poland

THE USE OF SURFACE EMG TO DETERMINE THE MUSCLE IMBALANCE

Keywords: : Muscle Imbalance, Surface EMG, Muscle Force, Muscle Excitation

Introduction: Muscle imbalance can mean that the muscle on one side of the body is not as symmetrical or as strong as on the other side. It often occurs in athletes who train only one discipline and constantly use the dominant side of the body, such as tennis players, golfers, and figure skaters. Muscle imbalance can also indicate problems with muscle work due to, for example, an imminent injury or abnormal performance of daily physical activity (e.g., professional work). Surface electromyography (sEMG) can be used to measure muscle excitation and can be a measure of muscle activity. The proposed method focuses on determining muscle imbalance based on the determination of the normalized level of muscle excitation.

Method: The proposed method processes the raw surface EMG signal to gain the level of muscle excitation from sEMG recordings. To obtain the level of muscle excitation, the EMG is smoothed by method based on the impulse interference filter, moving average filter and root mean square calculation (RMS). To compare and validate the chosen parameters of sEMG (e.g., amplitude) and determine muscle imbalance, additionally, muscle force values were recorded synchronously with the sEMG signal by the force sensor. Simultaneous recordings (sEMG and force) were made during physical exercises where participants (athletes) were asked to generate a maximum voluntary contraction (MVC). Muscle imbalance was calculated for both MVC measurements and deep squat activity (DSA). For DSA the sEMG signals were normalized dividing determined muscle excitation by the MVC value. Muscle imbalance was determined as the percentage difference in MVC for the chosen right and left muscles.

Results: The paper presents (Table 1) the operation of the proposed method and an example of the results of research carried out on eight athletes for rectus femoris during MVC and DSA.

Table 1 The values of force and %MVC for left and right muscles recorded during MVC and DSA exercises, and rations of force, MVC, %MVC and value of imbalance for eight subjects.

Subject	Force L (N)	Force R (N)	Force R/L	MVC R/L	% MVC L	% MVC R	%MVC R/L	imbalance %MVC R-%MVC L
1	357	427	1,20	0,86	23,02	28,82	1,25	5,80
2	294	398	1,35	1,34	13,29	26,16	1,97	12,87
3	308	351	1,14	0,50	76,69	37,93	0,49	-38,76
4	228	217	0,95	0,87	48,04	36,90	0,77	-11,14
5	239	239	1,00	0,97	69,26	57,42	0,83	-11,85
6	202	326	1,61	2,38	13,96	30,17	2,16	16,20
7	215	262	1,22	0,98	46,85	58,14	1,24	11,30
8	219	281	1,28	0,95	92,19	126,29	1,37	34,10

Conclusions: The preliminary analysis of the results presented shows that the proposed method of analysis of sEMG signals has the potential to determine muscle imbalance. The similarity between the rations of force, MVC, and %MVC may indicate the correctness of the calculation of muscle imbalance. The presented results could support the assessment of muscle imbalance and be interesting to some researchers conducting studies in the field of human movement analysis, sports, and kinesiology.