A PREDICTION OF 1RM THROUGH LIGHT WEIGHT EXERCISE WITH SURFACE EMG

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SUMMARY

This study was performed to show that 1RM can be measured by a small load and EMG. Seven healthy male volunteers participated in this study. They performed leg press exercise from 5kg to 65kg loads (interval 7.5kg). Then surface EMG data were simultaneously acquired from their quadriceps. First, subjects performed RM-test. When there are too many repetitions, 1RM determined by prediction equations showed much differences all. When subjects exercised with a small load, with increased load, the slope of the calculated IEMG values was gradually decreased. There was no significant change in the median frequency of the measured EMG. These results showed that 1RM prediction equations may not be applicable for patients and elderly people. On the other hand, we expect that the proposed method would be more applicable to predict 1RM.

INTRODUCTION

The one-repetition maximum (1RM) is important factor in strength assessment. 1RM is defined as the maximal weight that can be lifted once with correct lifting technique [1]. 1RM can be measured directly, however most people measure 1RM through indirect methods because direct method requires much effort and special training. 1RM can be measure with indirect method in which an individual performs multiple repetitions at a specified weight load and those results are entered into one of many prediction equations. However, this weight also can be heavy for patients with musculoskeletal disease and elderly people. And if there are too many repetitions, 1RM determined by the equations showed many differences all (Table 1). So using the equation is not suitable for patients don't know exactly their muscle strength. So this study experimented that 1RM can be measured by a small load. First, 1RM testing was performed by a small load and used 1RM prediction equations. Second, when exercising was performed by a small load, EMG was measured. Third, to see the effects of muscle fatigue, median frequency analysis also was done.

METHODS

Subjects consisted of 7 healthy adults (male, age = 26±2years, height = 175.10±3.19cm, body mass = 63.99±5.49kg). Subjects performed the five repetitions on each legpress exercise from 5kg to 65kg loads (interval 7.5kg). One repetition consists of two phases, leg extension for one second and leg flexion for one second using the metronome. The exercise's loads were adopted in random order. During the exercise, EMG was measured (Rectus femoris, Vastus laterlalis, Vastus medialis). Next, maximum voluntary contraction (MVC) was measured [2]. After exercise RM-test was conducted by 127.14±18.22kg load and the result was used in 1RM prediction equation [3]. EMG was measure by surface EMG device (MA-300, Motionlab system). And raw EMG was bandpass filtered (20-500Hz), full-wave rectified [4]. And integrated EMG (IEMG) was calculated by EMG measured during one exercise trial. Next, median frequency analysis was performed [5].

RESULTS AND DISCUSSION

IEMG value increased as load increased. However, IEMG's increases were gradually decreased. At certain load, IEMG value will not increase anymore. So we observed the slope of the IEMG. the load was increased, the slope of the IEMG was gradually decreased (Figure 1, Table 2). In addition the slope approached to nearly zero. When the slope converges to zero, the load weight would be considered 1RM.

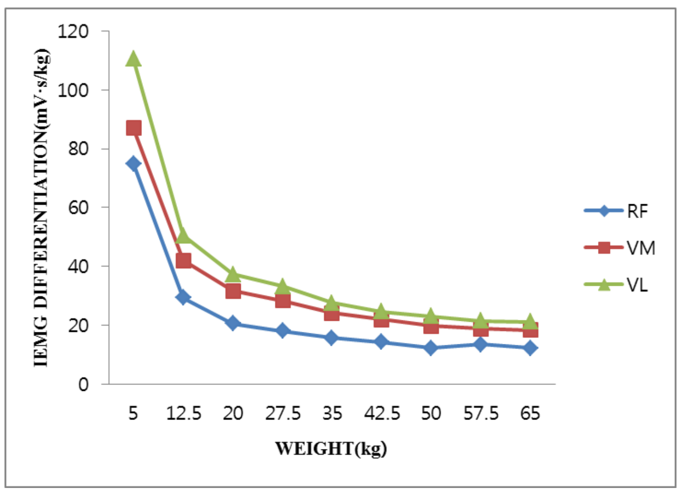

Figure 1: During exercise, the slope of the calculated IEMG.

The median frequency of the measured EMG was not significantly decreased or increased (Figure 2, table 2). This result proved that muscle fatigue did not occur [5]. However as the load increased, the median frequency slightly increased. This result can be explained by selective recruitment of fast-twitch motor units [6].

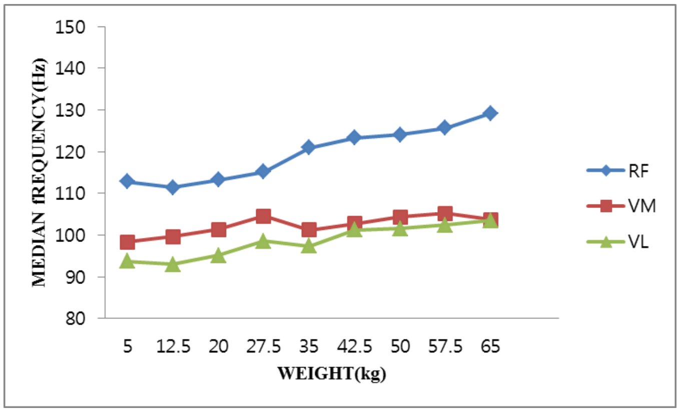

Figure 2: During exercise, the median frequency of the measured EMG.

CONCLUSIONS

Prediction equation can be used only in appropriate weight and repetition. If there are too many repetitions, 1RM determined by the equations are not accuarate. So we examined the relationship between EMG and load. IEMG value increased as load increased. However, IEMG's increases were decreased gradually. When IEMG value was not increase, the load is expected to 1RM. And our exercise procedure does not make fatigue and require much effort. We expect that the proposed method would be more applicable to predict 1RM.

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Table 1: 1RM value by 1RM prediction equation.

Subject		**1**		**2**		**3**		**4**		**5**		**6**		**7**	
Load (kg)	**Repetition**	95	26	125	24	147.5	10	125	14	132.5	28	117.5	13	147.5	20
Equation		**Predict 1RM (kg)**													
Wathen		168.3		216.7		198.8		184.8		239.2		170.1		242.6	
O'Connor et al		156.8		200.0		184.4		168.8		225.3		155.7		221.3	
Berger		183.0		228.5		186.8		175.8		268.9		161.0		242.8	
Lombardi		131.6		171.8		185.7		162.8		184.9		151.9		199.0	
Brzycki		311.5		346.6		196.7		195.7		531.3		176.3		312.6	
Lander		298.3		336.1		197.8		195.6		499.9		176.5		308.1	
Mayhew et al		152.7		197.2		193.1		174.6		216.6		161.6		223.0	

Table 2: The slope of the calculated IEMG and the median frequency of the measured EMG.

Load (kg)	**The slope of the calculated IEMG**						**The median frequency of the measured EMG**					
	RF (mV·s/kg)		**VM (mV·s/kg)**		**VL (mV·s/kg)**		**RF (Hz)**		**VM (Hz)**		**VL (Hz)**	
	mean	**S.D.**	**mean**	**S.D.**	**mean**	**S.D.**	**mean**	**S.D.**	**mean**	**S.D.**	**mean**	**S.D.**
5	74.98	10.37	86.91	17.08	110.38	28.40	112.85	5.01	98.34	6.05	93.77	4.86
12.5	29.39	3.28	42.00	8.97	50.45	9.69	111.40	5.30	99.66	6.60	93.03	6.57
20	20.65	4.70	31.67	6.98	37.26	8.21	113.29	10.17	101.38	9.03	95.09	5.79
27.5	18.03	3.15	28.41	8.41	33.20	5.70	115.18	8.69	104.58	10.16	98.56	6.22
35	15.68	4.53	24.17	4.37	27.61	2.68	120.98	8.83	101.25	9.31	97.38	6.90
42.5	14.29	3.56	21.94	4.55	24.63	2.90	123.35	8.62	102.70	6.75	101.25	9.87
50	12.21	3.51	19.83	4.99	23.16	2.78	124.10	12.58	104.32	9.65	101.55	10.34
57.5	13.53	4.39	18.80	3.84	21.47	1.68	125.72	10.41	105.24	8.65	102.43	11.46
65	12.36	3.22	18.38	4.14	21.25	1.16	129.24	12.06	103.71	9.27	103.49	11.47