

HIGHER RATE OF FORCE DEVELOPMENT IN UNILATERAL OUTPUT THAN BILATERAL OUTPUT DURING EXPLOSIVE ISOMETRIC MULTI-JOINT LEG EXTENSION

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INTRODUCTION

Maximum contraction muscle force decreased during both limbs acting simultaneously (bilateral contractions) compared with the sum of the forces produced during a each limb separately (unilateral contractions). This phenomenon was known as *Bilateral deficit* (BLD). It has been discussed BLD is affected by recruitment high threshold motorunits; decreased activation of fast motor units might be responsible for the BLD.

The rate of torque development(RFD) was lower in the bilateral than in the unilateral activation of single-joint extension(1,2). RFD refer to the output speed at which force can be produced, and on a neural level, RFD means that typically high threshold motor units are recruited at an earlier absolute time. One study found that three times as many motor unit were active during a ballistic contraction compared to a slow ramp contraction(3).

In most of ball game, such as football, handball, basketball, explosive produced output by one limb separately were shown. It would be beneficial for us to know the characteristic of one limb that different produce than bilateral.

It was hypothesized that if decreased activation of fast motor units is responsible for the BLD, it would be observed greater BLD on RFD than on force. The purpose of this study was to examine a difference of unilateral and bilateral output by explosive isometric leg extension.

METHODS

18 male subjects(age=19.9±2.8years, height=170.0±6.1cm, weight=60.9±6.3kg), who had been belonging in the Formula Racing School in Japan, took part in this study. As soon as trigger ramp lighted, subject reacted to generate maximum force with isometric leg extension movement at the knee angle of 130 degrees. Unilateral condition (each leg of right and left) and bilateral condition (both leg acting simultaneously) were performed two times each.

The absolute time from onset (7N above from base line) to peak force and 63% of peak force and peak force, the force on 63% of peak force were recorded and RFD was calculates as $dforce/dtime$ for both 63% and 100% force levels .

Force values (63% and peak force) and RFD (63% and peak force) were compared between unilateral (sum of right and

left) condition and bilateral condition. The definition of BLD for RFD (4) was as follows:

$$\text{Bilateral index (\%)} = 100 (\text{bilateral}/(\text{right}+\text{left}))-100$$

RESULTS AND DISCUSSION

Time 63% and time peak force were shorter in unilateral than bilateral. Therefore, motor unit activation may be greater in unilateral condition than bilateral condition.

We observed BLD in force 63%, peak force, RFD on 63% and RFD on peak force. But, greater BLD were shown in both RFD (especially on 63%) than BLD obtained from peak force alone. This is may be influenced by motor unit activation, because RFD normally refer to the output speed at which force can be produced. High threshold motor units (fast motor units) may recruite at an earlier absolute time in unilateral condition than in bilateral condition.

Previous study observed that decreased activation of primarily fast motor units in bilateral condition during step than ramp test. We evaluated RFD that refer to the speed of neural flow and force that produced without speed in unilateral and bilateral. RFD responsible for fast motor unit activation may cause decrease in bilateral RFD compared to unilateral RFD.

CONCLUSIONS

We examined a difference of unilateral and bilateral rate of force output during explosive isometric leg extension. As BLD were observed for both on force and on RFD, more pronounced BLD was observed on RFD. These findings may be explained by higher recruitments of high threshold motor units in unilateral maximum isometric leg extension.

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Table.1: Mean value (±SD) in reaction time, time63, time peak force, force63%, peak force and RFD (N/s) from both leg, right and left output.

	<i>ReactionTime</i> <i>sec</i>	<i>Time63%</i> <i>sec</i>	<i>TimePeakForce</i> <i>sec</i>	<i>Force63%</i> <i>N</i>	<i>PeakForce</i> <i>N</i>	<i>Force63%/Time63%</i> <i>N/sec</i>	<i>PeakForce/TimePeakForce</i> <i>N/sec</i>
<i>both</i>	0.198 ±0.02	0.181 ±0.05	2.122 ±0.47	2560 ±520	4061 ±826	14573 ±4250	1997.6 ±603
<i>right</i>	0.189 ±0.02	0.156 ±0.05	1.751 ±0.62	1369 ±221	2171 ±351	9513 ±3022	1414.4 ±595
<i>left</i>	0.189 ±0.03	0.138 ±0.04	1.781 ±0.73	1276 ±231	2022 ±365	9900 ±3271	1344.1 ±647
<i>bilateral deficit</i>				-3.5 ±9.2	-3.4 ±9.2	-23.1 ±18.0	-20.1 ±29.4