LOWER LIMB FORCE, POWER AND PERFORMANCE IN SKATEBOARDING

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The aim of this study was to quantify the contribution of muscle force and power of the lower limbs to the performance of the Ollie in beginner level skateboarders. Ten male athletes who had practiced for at least two years were submitted to three kinds of test: (1) maximal voluntary contraction of the knee and hip extensor muscles; (2) vertical jump tests, Counter Movement Jump (CMJ) and Squat Jump (SJ); and (3) a test developed specifically for this study, to measure the maximum height achieved during the Ollie manoeuvre. The data obtained were submitted to simple linear regression analysis. The results demonstrate that the variance of the Ollie manoeuvre ($p<0.05$) is explained by the power estimated with the CMJ (76.3%); and the maximal force of the knee extensor muscle (50.6%). The body mass is the determinant factor to the performance of the Ollie.

KEY WORDS: skateboarding, power, force, Ollie.

INTRODUCTION:

In recent years the practice of skateboarding has become increasingly popular as well as more professional. In 2002, Brazil had approximately 2.7 million practitioners of skateboarding, a figure that has certainly grown to date. According to the Brazilian Confederation of Skateboarding (CBSK) there are about ten thousand athletes who participate of championships in Brazil and, despite this apparent growth of skateboarding, there are few published studies on the performance of the skaters and skateboarding.

Although there are many modalities of skateboarding, like, Street, Mountainboard, Downhill and Vertical, the first is the most popular among practioners around the world. The Ollie is the basic skateboarding manoeuvre and consists of a jump where skate and the athlete rise from the ground and return in continuous movement (Bobbert, 1986). This manoeuvre makes it possible to go up and/or go over an obstacle, and the majority of the other manoeuvres are combinations of the Ollie with turns of the skateboard and the body of the athlete (Bridgman et al., 1992; Canavan et al., 2004). Given that the Ollie manoeuvre is involved in almost skateboarding movements it is important to study it in order to improve the performance of the athletes.

Scientific research into skateboarding began very recently, and rarely do skaters have access to scientifically-based training. The performance of a movement depends on the technique and the muscular force employed. In the case of the Ollie, the variables involved in its performance are muscular power, the capacity of using the stretching-shortening cycle (SSC), the coordination of neuromuscular contraction, the positioning of the feet on skateboard, the joint angles used to acquire jump impulse, the size and angle of inclination of the tail (posterior part of skateboard), the weight of the skateboard and the height of the shape (wooden platform covered by sandpaper) in relation to the ground. However, the contribution of each of these variables towards the performance of the manoeuvre still remains unknown, though muscle force and power probably play an significant part in performance of this manoeuvre (Fukashiro & Komi, 1987).

While two studies (Bridgman et al., 1992; Fukashiro & Komi, 1987) were found in the literature on the subject of the performance of the Ollie manoeuvre, many questions remain. Therefore, the purpose of this study was to quantify the contribution of muscle force and power of the lower limbs to the performance of the Ollie manoeuvre in beginner level skateboarders in order that trainers and skateboarders might benefit from this information.

METHOD:

Subjects: Ten males with a mean age of 10±3.70 years; body mass 62.7±9.5kg and height 172.2±10.6cm volunteered to participate in the experiment. All subjects are practitioners of Street category, having at least two years experience and participating in competitions at Beginner, Amateur II or Amateur I categories. The subjects were informed of the procedures of the research and signed a free informed consent term prior to participation.

Isometric Maximal Voluntary Contraction (IMVC): in each leg, IMVC of the hip and knee extensor muscles was performed three times, for approximately 5 s, with a two-minute interval between trials. The right inferior member was always the first to be evaluated and a uni-dimensional load cell was attached to a metallic device, so that the direction of the measured isometric force was perpendicular to the evaluated limb. The subjects received strong verbal encouragement. To assess the knee extensor muscle force (KE.), knee isometric extension was performed in a seated position, with a back rest, thighs securely fixed by straps with the knees at an angle of 90º. All the subjects were fastened at the level of the ankles by a leather belt attached to the load cell. To assess the muscle force of the hip extensors (HE), a hip isometric extension was performed on a bench, with the subjects in a prone horizontal position, with the lower back securely fixed by straps, and the hips and knees flexed. All the subjects were fastened at the level of the thighs by a leather belt attached to the load cell. The force signals were obtained using a load cell (EMG System do Brazil Ltda, São Jose dos Campos) connected to a 200 MHz Pentium microcomputer, by means of an A/D converter (EMG System do Brazil Ltda, São Jose dos Campos). The signals were obtained with AqDados software (Lynx Electronic Technology Ltda, São Paulo), with a sampling frequency of 500 Hz.

Vertical Jump tests: Two types of jump assessments were performed by each subject: 1) squat jump (SJ) and 2) countermovement jump (CMJ).The participants were instructed to keep their hands on their hips for the duration of the jumps. After three sub maximal warm-up jumps, the subject did a series of at least 3 maximal jumps with two-minute rest intervals between jumps. The SJ series was done first. In order to assess the SJ, the subjects were instructed to jump as high as possible starting from a squatting position with the knees at 90º. A successful trial was one where there was no sinking or countermovement prior to the execution of the jump. In order to assess the CMJ, the subjects were instructed to sink as quickly as possible and then jump as high as possible. The maximum height was registered by points (marks) made on the wall with chalk dust on the fingers of the hands of the subjects

Ollie manoeuvre evaluation: In order to measure the maximum height achieved during the Ollie manoeuvre an apparatus was specifically developed to represent an obstacle to jump over. This device made it possible to regulate different heights. First, each subject was asked to estimate their maximum height and perform a series of three warm-up jumps over the device at 50% of the predicted maximum height. After, the height of device was set to 10-20 cm below the predicted maximum height and the test consisted of clearing this height followed by stepwise increases in height of 5cm with two-minute intervals between attempts, with a maximum of four attempts at each height. When the subject was not successful at four consecutive jumps, the test was finalized and the best height registered. The validity of the test was verified during a pilot study using a test and re-test procedure with an interval of seven days between them. The results showed a high and significant correlation between the two test days ($r=0.96$; $p=0.000$) and demonstrated the validity of Ollie evaluation protocol.Data Analysis: Data analysis of force signals during CVIM test was performed using the AqDados 7.0 data acquisition system (Lynx Electronic Technology Ltda, São Paulo). The average force values obtained from the three trials of each CVIM test was calculated. The maximum value obtained in the Ollie evaluation was registered. The highest values obtained during the CMJ and SJ tests were considered. These values were used to predict the lower limb power using equations 1 and 2 (Johnson et al., 1996, Harman et al. 1991). Statistical analysis: A Simple Linear Regression was used to determine the best predictors in the performance of the Ollie Jump. Significance was set at $p<0.05$.

$$PCMJ = (78{,}5 \cdot CMJ) + (60{,}6 \cdot m) - (15{,}3 \cdot est) - 1308 \quad (1)$$

$$PSJ = (61{,}9 \cdot SJ) + (36 \cdot m) - 1822 \quad (2)$$

where:

PCMJ: power of inferior limbs from CMJ (W)
PSJ: power of inferior limbs from SJ (W)
CMJ: height registered from CMJ(cm)
SJ: height registered from SJ (cm)
m: body weight (kg)
est: height (cm).

RESULTS:

Table 1a presents the mean values and standard deviations of the vertical jump tests, Ollie jump heights, the forces of the knee and hip extensor muscles and lower member muscular power. No significant difference was found between the force values of the dominant and non-dominant member and the lower muscular power was greater when the it was calculated using the CMJ height values. Given that the R^2 values indicate the percentage of variance of the dependent variable that can be explained by the independent variables, the results demonstrated that 76.3% of the Ollie jump variance can be explained by the PCMJ, or further, 76.1% by the corporal mass and 50.6% by the knee extensor muscle force on the dominant side (K.E.D) (Table 1b). Thus, the values obtained for the independent variables of interest (IV) can, in the generic prediction equation (3), be substitued so they predict performance in the Ollie manoeuvre.

$$Ollie = const + \beta \cdot IV \quad (3)$$

Table 1 a) Mean values and standard deviations of SJ, CMJ, Ollie height and muscular force and power values. * knee extensors (K.E.); hip extensors (H.E.), dominant (D) and non-dominant side (ND); lower member power estimated from SJ (PSJ) and CMJ (PCMJ). b) Contribution in percentile (R^2) of the independent variables in the performance of the Ollie (dependent variable). *p<0,05; const= constant values obtained from the linear regression for each VI; β= regression coefficient; BM=body mass.

a)

Jumps (cm)		
SJ	**CMJ**	**Ollie**
35.3 ± 4.7	44.4 ±6.3	64.5 ±9.2

Force (kgf)			
K.E.D	**H.E.D**	**K.E.ND**	**H.E.ND**
43,2 ± 9,9	79,2 ± 26,3	44,2 ± 13,8	8,6 ± 27,1

Power (W)	
PSJ	**PCMJ**
2615 ± 516	3335 ± 855

b)

	R^2	const	β	F	Sig.
PCMJ	.763	32.96	0.009	25.7	.001
BM	.761	11.16	0.851	25.4	.001
PSJ	.684	25.66	0.015	17.3	.003
K.E.D	.506	35.96	0.660	8.1	.021
H.E.D	.488	44.99	0.246	7.6	.025
K.E.ND	.423	46.57	0.223	5.8	.042
H.E.ND	,358	46,77	0,401	4,4	,068

DISCUSSION:

The results showed that all independent variables are important for performance in the Ollie manoeuvre, except the K.E.ND (Table 1b). Given that the CMJ test, like the Ollie jump tests involves the stretch-shorten cycle (SSC), a higher correlation was expected between the Ollie manoeuvre and the CMJ than between the former and the PSJ. The results indicated that 76.3% of the performance in Ollie manoeuvre is determined by the lower limb power. These values suggest that 23.7% are associated to the technique used (force applied) and manufacturing characteristics of the skateboard. The correlation between the maximum isometric strength and the height achieved in the Ollie manoeuvre was not as high as expected. This was probably due to the fact that the speed which the body rises depends on starting strength, explosive strength, and the contribution of other muscle groups, especially those with a high percentage of type II fibres. However, these results are in accordance with other studies in which knee extensor muscle force was shown to contribute 50% towards the performance of the vertical jump (Nagano, 2005), while in the present study the correlation was 50.6 % for this muscular group in the Ollie manoeuvre. The force values of the knee and hip extensors of the non-dominant leg presented a lower correlation to the height achieved in the Ollie manoeuvre, and the knee extensor force values were insignificant. This suggests that the force that the athlete applies to skateboard is greater in the dominant leg and that the hip extensor muscles make a greater contribution in the performance achieved in the Ollie manoeuvre than the knee extensor muscles. The results obtained for power seem to be in accordance with other studies (Bobbert et al., 1986, Fukashiro et al.,1987, Nagano, 2005). Equation 1 was chosen for the CMJ because it takes into consideration the stature value of each subject. Also, this equation was shown to be an efficient predictor of power in 16 high performance junior volleyball athletes (Tompos, 2003).

CONCLUSION:

The results of the present study suggest that, for beginner level skateboarders, when performing the Ollie manoeuvre, the variables power and muscular force are determinant.

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