Accuracy and reliability of the Myotest Pro system to evaluate a squat jump

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Abstract

During the past five years, systems with small accelerometers have been increasingly used to measure human sport motion. Few studies have defined the measurement error and limit of agreement of those systems in the particular case of squat jump when the sensor is directly fixed to the athlete. The aim of this study is to define the measurement accuracy of the centre of mass of the subject with the use of the Myotest Pro system (Myotest SA, Swiss). The reliability of the Myotest Pro system measurement is compared to those of a force platform. Nine male subjects performed squat jumps on a force platform. The data of both the tools (force platform and the Myotest Pro system) are synchronized at the instant of maximal velocity (Vmax). For each jump, data of the force platform and Myotest Pro were converted to define maximal velocity (Vmax), take off velocity (Vtoff) and the flight time (t), using the same method. Paired t-test, r correlation coefficient and Bland & Altman test were used to compare the validity and the limit of agreement between the two tools. Results showed no significant difference between the measurements of Vmax and Vtoff. Significant difference was observed between the measurements of t ($p < 0.005$). The correlation between the tool's measurements for Vmax, Vtoff and t is respectively $r > 0.92$, $r > 0.58$ and $r > 0.77$. Bland & Altman test shows very low bias and high reliability (± 0.125 m.s-1) between tools for Vmax data. Bland & Altman test shows a significant under estimation of the bias for t data of the Myotest Pro system and low reliability for Vtoff data (± 0.35 m.s-1). In conclusion, the Myotest Pro system can only be used to evaluate Vmax of subject's centre of mass during a squat jump with acceptable accuracy and reliability. Myotest Pro cannot be used to estimate other kinetic's parameters of the centre of mass of the subject during a squat jump. These results can be explained by the hypothesis of measurements between both tools (centre of mass versus side of the hip).

Keywords: Accelerometer; squat jump; Myotest Pro; accuracy; reliability; human motion.

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1. Introduction

Human motion measurements present interest in the aim to improve the subject's performance and ability [1] [2]. Height and velocity of the center of mass measured during vertical jump have been widely applied as functional approach to access muscular [3], coordination [1] [2] [4] and physical capacities [5 -8] in human motion and training sport. Kinematics (VICON, etc.) and kinetic systems (force plate, etc.) have been usually used to realize accurate measurements of the center of mass [1] [5]. But these methods require to reduce measurements at laboratory or very constraining conditions [5] [10] [11]. During the past five years, devices with small accelerometer have been increasingly used to measure human motions in sports [5] [6] [9]. For example, Myotest SA proposes to measure specific human motion in sport training (squat jump, bench press, etc.) using Myotest Pro sensor [5] [9]. These studies focused on measurement accuracy of this tool during bench press motion [9] and squat jump [5]. In these cases, the sensor was attached on the fitness bar, in the aim to limit the rotation motion [5] [9]. In these cases, low reliability and systematic bias have been already observed [5] [9]. Few studies estimated the accuracy and reliability of a sensor directly attached on the subject during motion like squat jumps [7]. The aim of this study is to define the accuracy and reliability to estimate kinetics' variables of the centre of mass using the Myotest Pro during squat jump. Data of this sensor are compared with a reference force plate.

2. Methods

Nine male subjects (mean ± standard deviation SD: height = 179.8 ± 5.2 cm; mass = 76.02 ± 6.9 kg) voluntarily participated to this study. All subjects were asked to perform three squat jumps without arm movement (with their hands on the hips). All the squat jumps were performed on a force plate (Kisler, 500 Hz). For each subject, only the best squat jump was studied. The Myotest Pro system includes a triaxial accelerometer (500 Hz) sensor [5] as well as software developed by Myotest SA. For each jump, the sensor Myotest Pro was fixed vertically at the side of hip's athlete, on the coxo-femoral joint in agreement with Myotest SA recommendations. In the training mode of the Myotest Pro software, it defines the vertical acceleration of the subject and then estimates the maximal velocity (Vmax). In order to determine velocity of the subject centre de mass on the vertical axis, numerical integration of the acceleration data were performed using trapezoidal rule. Velocity on the vertical axis of both measurement tools (force plate and Myotest Pro System) were used to calculate the vertical maximal velocity of the subject during the impulse phase of the squat jump (Vmax in m.s-1), the vertical velocity at take off (Vtoff, in m.s-1) and the flight time of the subject (t in s). The acceleration data on vertical axis of both tools were synchronized when the acceleration data is equal to zero before the subject takes off. A paired t-test was used to compare the significant difference between the kinetics' variables (Vmax, Vtoff, t) measured with the devices (Myotest sensor, force plate). Correlation coefficient (r) was used to estimate the relation between the kinetics' variables measured with both devices. A Bland and

Altman test [12] was used to define the accuracy and reliability between the kinetics' variables of both devices.

3. Results

Results showed no significant difference between the measurements of Vmax and Vtoff (Table 1). Significant difference was observed between the measurements of t ($p < 0.05$). Correlations between measurement for Vmax, Vtoff and t are respectively $r > 0.92$, $r > 0.58$ and $r > 0.77$ (Table 2). Bland & Altman test shows very low bias and high reliability (± 0.125 m.s-1) between tools for Vmax data (Figure 1). Bland & Altman test shows a significant under estimation of the bias for t data of the Myotest Pro system and low reliability for Vtoff data (± 0.35 m.s-1) (Figures 2 and 3).

4. Discussion and Conclusion

Results show that the Myotest Pro system can be used to evaluate Vmax of subject's centre of mass during a squat jump with acceptable accuracy (error > 0.3 m.s-1) and reliability (bias < 0.1 m.s-1). The Myotest Pro estimate Vtoff with a small validity (95% limit of agreement > 0.8 m.s-1) and under estimate t with a significant different bias (> 0.03 s). So it cannot be used to estimate Vtoff and t of subject's centre of mass. Difference between results on Vtoff and t on both devices can be explained by the hypothesis of measurements of the Myotest Pro. If the centre of mass is currently used to evaluate the squat jump performance [1 - 8], the Myotest Pro sensor can only estimate the acceleration of the point where it is fixed. In contrary to some study where soft development takes into account the position of the accelerometer to estimate the centre of mass kinetic's variables (Vmax, Vtoff, t) [6]; the Myotest Pro system only estimates the hip motion. In conclusion, the Myotest Pro can be used only to estimate Vmax of the center of mass during a squat jump, or Vtoff and t of the hip where it is fixed. Force plate or other sensors [6] could be preferred to estimate kinetics variables of the centre of mass.

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Table 1. Mean and standard deviation values of Vmax, Vtoff and t between Myotest Pro and force plate measurements.

Variable	Force plate	Myotest Pro
Vmax	2.4±0.2	2.46±0.21
Vtoff	2.21±0.22	2.2±0.22
t	0.45±0.05	0.42±0.04*

*p < 0.05 Myotest vs. force plate

Table 2. Significant correlation between Myotest Pro and force plate measurements.

Variable	R Value
Vmax	0.92**
Vtoff	0.57
t	0.74*

*p < 0.05; **p < 0.01

Fig. 1. Bland and Altman plot depicting the limits of bias (green) between the two devices of measurement and the 95% limits of agreement (red) for Vmax.

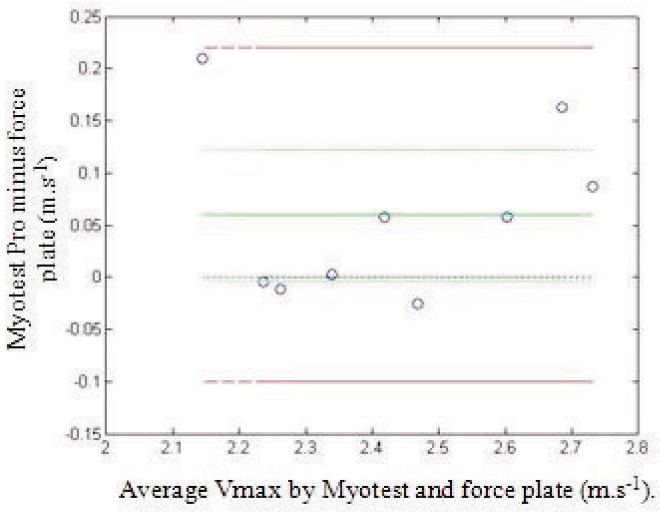

Fig. 2. Bland and Altman plot depicting the limits of bias (green) between the two devices of measurement and the 95% limits of agreement (red) for Vtoff.

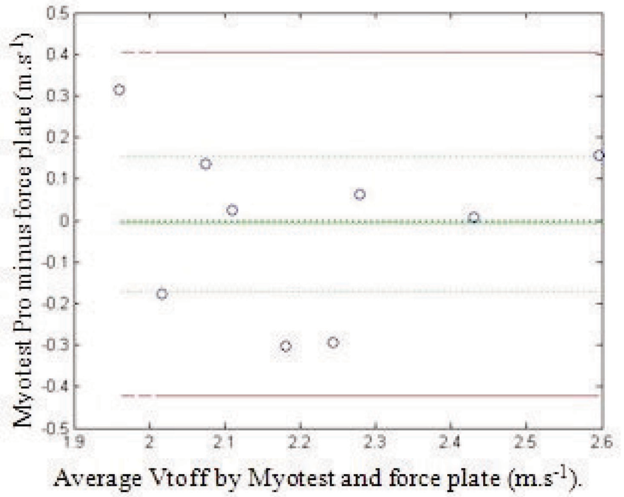

Fig. 3. Bland and Altman plot depicting the limits of bias (green) between the two devices of measurement and the 95% limits of agreement (red) for t.