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Journal of Sports Science and Technology Volume 18, No. 1, July 2018

THE VALIDITY OF CHRONOJUMP SYSTEM ® TO MEASURE VERTICAL JUMP

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ABSTRACT

Several devices have been used to measure vertical jump tests. A force platform (FP) is a standard device for vertical jump measurement since it provides more valuable information beside jump height such as force, rate of force development, ground contact time, etc.; however, the cost of FP is very high. Thus, an alternative device such as a contact mat has been used due to its lower cost. A Chronojump system (CS) is a low cost contact mat which is available with an open-source software. Nevertheless, its validity has not yet been determined; thus, the purpose of this study was to compare jump parameters including flight time (FT) and ground contact time (CT) between CS and a FP. Thirty healthy collegiate male athletes age ranges between 18-25 years old were participated in this study. After warm-up, all athletes performed 4 trials of 2 jumps; countermovement jump (CMJ) and drop jump (DJ) trials on a FP which the contact mat was placed on the top. Flight time (FT), contact time (CT) and jump height (JH) were compared using Bland and Altman method. Bland and Altman revealed no significant differences of jump parameters between two devices but CT derived from CS was underestimated as compare to FP. In conclusion, it seems that a contact mat of CS was found to be a valid jump measurement device. However, CT in DJ may need to be interpreted with caution.

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Keywords: Vertical jump height / Force platform / Chronojump / Validity

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การเปรียบเทียบพารามิเตอร์ของการกระโดดสูงระหว่างระบบโครโนจัมพ์และแผ่นวัดแรง

เจริญ ลูกอินทร์[1] เมตตา ปิ่นทอง[1] กรกฤษณ์ ชัยเจนกิจ[1],
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บทคัดย่อ

เครื่องมือที่ใช้ในการทดสอบการกระโดดสูงมีมากหมายหลายประเภท แผ่นวัดแรง (FP) เป็นเครื่องมือมาตรฐานที่ใช้ในการทดสอบการกระโดดสูง เพราะให้ข้อมูลที่สำคัญนอกเหนือจากความสูงในการกระโดด เช่น แรง อัตราการพัฒนาของแรง ระยะเวลาที่สัมผัสพื้น ฯลฯ แต่อย่างไรก็ตาม แผ่นวัดแรงมีราคาสูงมาก ดังนั้น เครื่องมืออื่น เช่น contact mat จึงถูกนำมาใช้เนื่องจากมีราคาที่ถูกกว่า ระบบโครโนจัมพ์ (CS) เป็น contact mat ราคาถูกที่มาพร้อมกับโปรแกรมโอเพนซอร์ส อย่างไรก็ดี ความเที่ยงตรงของระบบนี้ยังไม่ได้ถูกทดสอบ ดังนั้น วัตถุประสงค์ในงานวิจัยนี้ เพื่อต้องการเปรียบเทียบพารามิเตอร์ของการกระโดดสูง ได้แก่ เวลาที่ลอยอยู่กลางอากาศ (FT) และเวลาที่สัมผัสพื้น (CT) ระหว่าง CS และ FP นักกีฬามหาวิทยาลัยเพศชาย จำนวน 30 คน อายุระหว่าง 18-25 ปี เข้าร่วมในงานวิจัยนี้ หลังจากอบอุ่นร่างกาย นักกีฬาทั้งหมดจะทำการกระโดด 2 ท่า ท่าละ 4 ครั้ง คือ ท่ากระโดดแบบ countermovement jump (CMJ) และ drop jump (DJ) บนแผ่นวัดแรงที่มี contact mat วางทับอยู่ด้านบน เวลาที่ลอยอยู่กลางอากาศ (FT) และเวลาที่สัมผัสพื้น (CT) และความสูงการกระโดด (JH) ระหว่างเครื่องมือ 2 ประเภท จะถูกเปรียบเทียบโดยใช้วิธี Bland และ Altman ซึ่งไม่พบความแตกต่างอย่างมีนัยสำคัญทางสถิติของพารามิเตอร์ของการกระโดดสูงระหว่างเครื่องมือ แต่ค่า CT จาก CS จะมีค่าต่ำกว่า FP โดยสรุป contact mat ของ CS เป็นเครื่องมือที่มีค่าความเที่ยงตรง อย่างไรก็ตาม ค่า CT ของ DJ ในการแปลผลควรทำด้วยความระมัดระวัง

วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา 2561; 18(1) : 8-15

คำสำคัญ: ความสูงการกระโดดในแนวดิ่ง / แผ่นวัดแรง / โครโนจัมพ์ / ความเที่ยงตรง

วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 18 ฉบับที่ 1, กรกฎาคม 2561
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INTRODUCTION

Vertical jump tests have been extensively used to assess strength and explosive power output in the extensor muscles of the lower limbs.[7,9] Explosive power is required when athlete increases the speed or quickly changes the direction. Therefore, vertical jump tests also have been used to monitor training program in various sports, specifically soccer, basketball, and football. [10] A force platform (FP) is a key competent found in most biomechanics laboratories. It is a versatile device that among other things can be used to measure vertical jump height[5]. Besides the magnitude of the vertical jump, a FP can also asses other jump parameters such as contact time (CT), take off force, power, rate of force development[1]. If height was the only desired measurement then a vertical jump stand or a simple measureing tape on the wall would suffice. For research the FP is considered to be a 'gold standard' device because of its accuracy and reliability[7], however it is expensive and not easily portable.

Contact mats are an option that commonly is used for evaluating vertical jump height in the field[7], they are relatively inexpensive and are by design, portable. Commonly used products include just jump, sport jump v-1.0 etc. While these devices can provide information such as CT and FT, they cannot provide any data regarding force. The Chronojump system (CS) (Chronojump-Boscosystem, Spain) is a low-cost contact mat style device with the benefit of using open-source software programing. Pagaduan & Blas[11] (2012) investigated reliability of this device on CMJ. Fifteen male college students (age: 20.0 ± 2.4 yrs; height: 162.4 ± 27.3 cm; weight: 74.5 ± 28.6 kg) volunteered to participate in the study. They achieved two trials of a 20-kg loaded countermovement jump for two session separated by one day rest interval. The results showed that this device had a high reliability (Intraclass Correlations = 0.86). However these authors did not evaluate the validity of this device. Therefore, the purpose of this study was to assess the criterion validity of the *CS* as compared to the gold standard, a FP.

METHODS

Thirty healthy collegiate male athletes (18 to 25 years of age) participated in this study.Participants were from university sport team and were excluded if they had musculoskeletal injury particularly in lower extremity in the past 6 months or had history of lower extremity surgery. All participants provided their signed informed consent, which was approved by Mahidol University Central Institutional Review, Board (2015/090.1206).

The contact mat CS consisted of a chronopic controller, which was connected to a computer via USB port. The data was collected via the CS open software program. A (Kistler Type 9286BA, Kistler Group, Winterthur, Switzerland) force platform was connected to the workstation computer. The BTS SMART capture software (BTS Bioengineering Inc., Italy) was used to collect data at sampling rate 800 Hz. The CS contact mat was placed on the top of the force platform such that the data (FT and JH of CMJ and CT, FT and JH of DJ) for both systems were collected simultaneously.[13]

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Prior to data collection, participants were asked to warm up by lower body active stretching for five minutes. Then, participants were familiarized with the protocol for 2 jump test; CMJ and DJ and performed 2 submaximal jumps with resting between 15-second before data collection. For the CMJ, participants started from an upright standing position with hands resting on their hips. At the go signal, participants dropped quickly into a semi squat and then rapidly jumped vertically as high as possible. When their feet contacted the ground, Participants was allowed to flex their knees to reduce the impact of landing. For the DJ, participants stood upright with hands resting on their hips on top of a 30-cm high box. After hearing the go signal, participants stepped off the box, landed on both feet into semi squat (around 40 degree of knee flexion)to the ground, and immediately jump vertically back to the air with maximum power as quickly as possible[7].

The order of CMJ and DJ was randomly assigned. For each test, participants performed 4 repetitions for each jump. A 15-second rest was allowed between each trial and a minute rest was given between the two jump conditions. Successful jump tests were defined as when both takeoff and landing was done with both legs simultaneously. All tests were conducted in the same facility, under the same conditions.

Data analysis

Based on Buckthorpe and colleague's study[4] (2012), to achieve power of 80%, the sample size required for this study was 102 jump. In this study, each subject jumped 4 times for each jump condition. Thus, the totals of 30 subjects were recruited to achieve the total of 120 jumps. Criterion validity assessment was employed with the Bland and Altman 95% limits of agreement (Bland & Altman, 1986).

RESULTS

Mean age (±SD), weight and height were 20 (1.54) years old, 65.3 (8.7) kg, and 172.2 (6.49) cm, respectively.

Figure 1 displays limits of agreement between the 2 devices of CT, FT and JH during the DJ. The mean difference of CT between the two devices was 0.001 sec (±0.0045). It is expected that 95% of difference would be below (0.001+[1.96 x 0.0045]) and above (0.001–[1.96 x 0.0045]), that represents upper limit of agreement (0.0098 sec) and lower limit of agreement (-0.0077 sec). The mean difference of FT was -0.0005 sec (± 0.0053), resulting in 0.0098 sec and -0.0108 sec limit of agreement. For JH, the mean difference was - 0.0625 cm (± 0.7104) while upper limit of agreement was 1.3298 cm and lower limit of agreement was -1.4548 cm.

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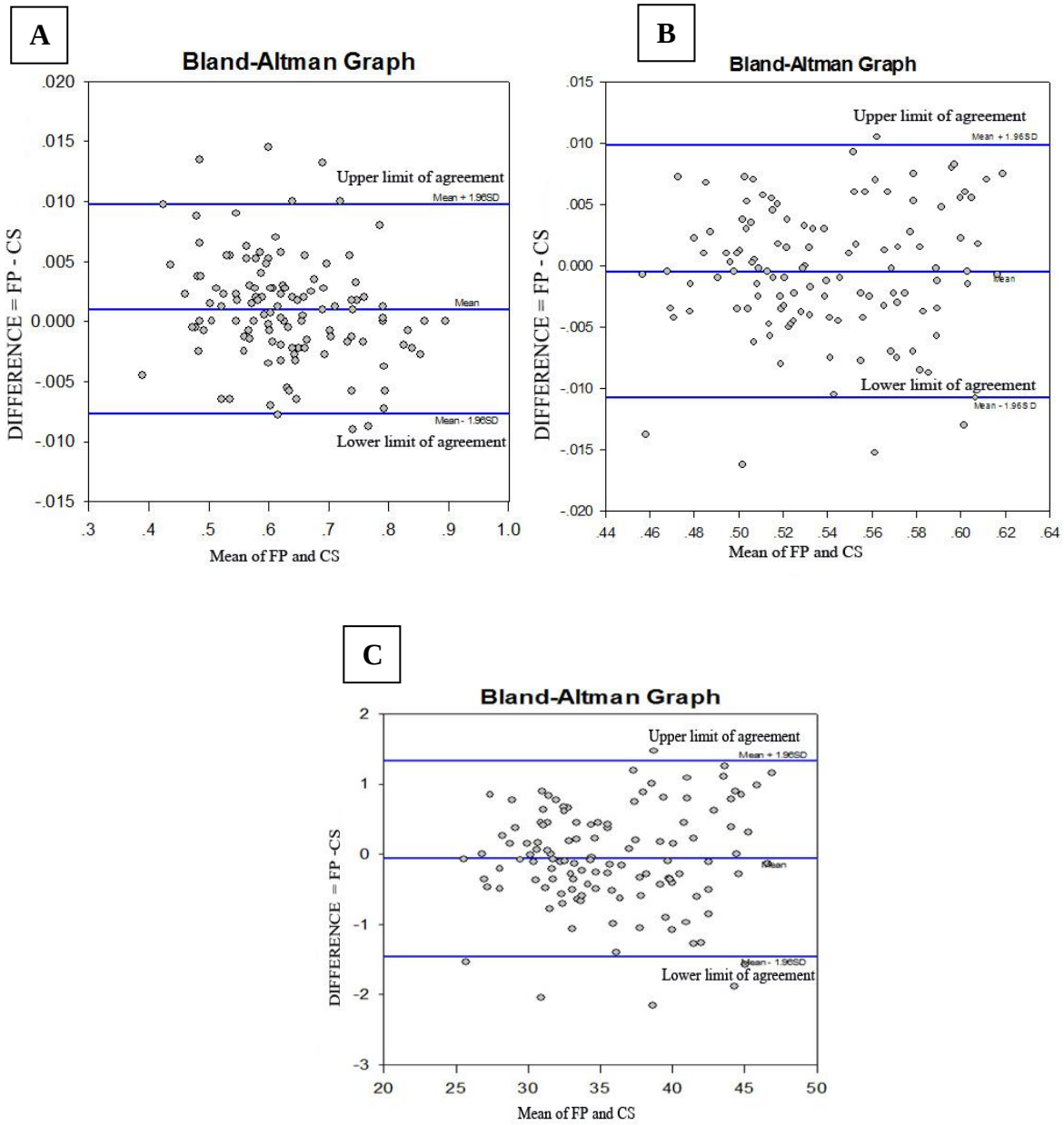

Figure 1: Bland and Altman plots of CT (A), FT (B) and JH (C) between the two devices of DJ. The upper and lower lines show the 95% limits of agreement.

The bias (differences) between the 2 devices and the 95% limits of agreement during CMJ were calculated to reveal the degree of agreement between the two methods (Figure 2). Mean difference the flight time is - 0.0005 sec (±0.0049). The upper limit of 95% different agreement is 0.0092 sec and lower limit of agreement is -0.0102 sec. The mean difference of jump height is -0.0694 cm (± 0.6433) whereas the upper limit and lower limit of agreement are 1.1915 cm and -1.3303 cm, respectively.

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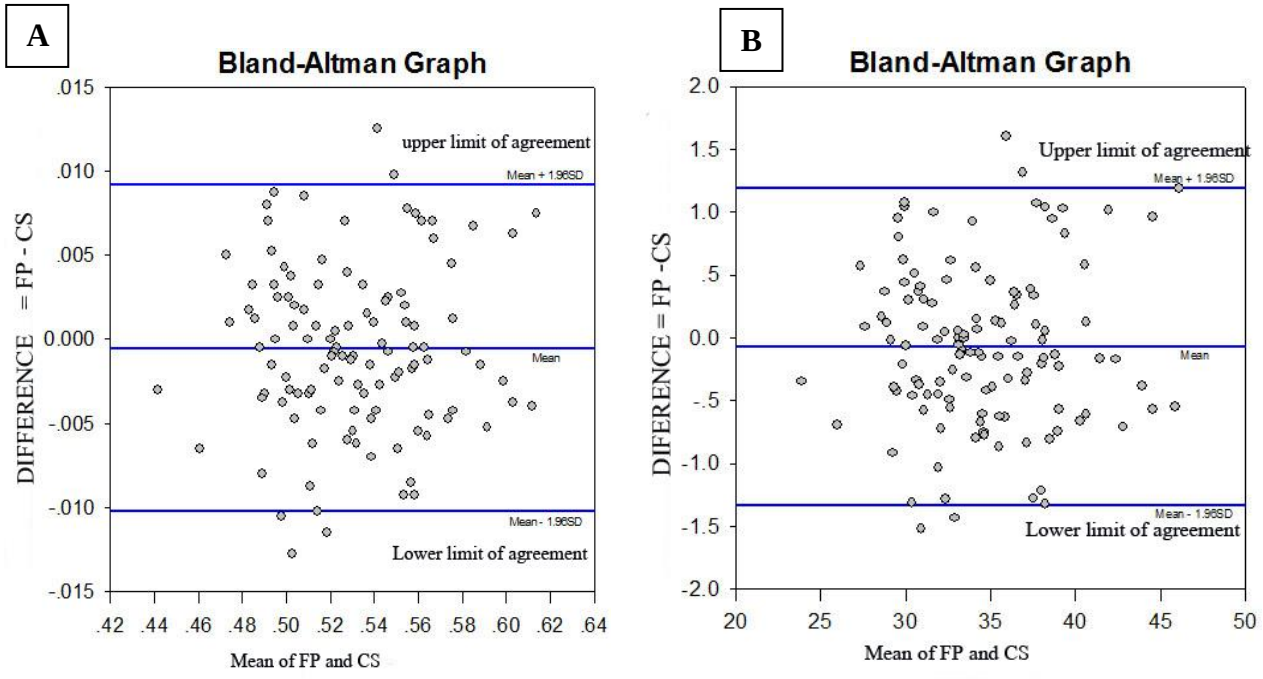

Figure 2. Bland and Altman plots of FT (A) and JH (B) between the two devices of CMJ. The upper and lower lines show the 95% limits of agreement.

DISCUSSION

The aim of this study was to assess the validity of a low-cost vertical jumping measurement device, CS *to measure* FT and JH of CMJ. Additionally, we were interested in how accurate it could measure contact time. Thus, we included the DJ test. The outcomes revealed this device was comparable to a force platform (gold standard measurement)[12] Bland and Altman (1986) was applied to analyze the absolute agreement between the two methods. It is advised that 95% of the difference should be located in these limits of agreement. In our study, examination of Bland-Altman plots indicated a good agreement in FT and JH of CMJ between two methods but there were some differences in contact time of DJ.

Regarding to concurrent validity, Bland and Altman plots indicated graphically small differences in contact time variables. It was found that contact time during drop jump test was systematically lower when measured with the low cost device. However, for the CMJ, all variables are in the good agreement. Garcia Lopez et al[8]. (2005) investigated two vertical jump devices; the CM and a photocell mat (SportJump system) with the force platform. They found that there were no differences between SportJump System and FP to measure JH calculated from FT (95% Confident Interval = 10.4-10.9 ms of FT and 0.013-0.015 m of JH) and recommended that the photocell mat is more useful than contact mat because the fault of contact mats when assessing flight time is less predictable due to several factors including hardness of mat, participants' body mass, and jump height. Nevertheless, there was no significant difference between the 2 devices as compared to a force platform. Although the device of the current

study is different from the previous study[8], the results are quite similar. However, the low cost device displayed a slightly higher value than the force platform in both FT and JH. This may be due to sensitivity of contact detection of contact mat as mentioned above.[8] The current study used a rubber mat which is yield some absorption during impact. Unlike, most force platform which made of the steel.

This study is a novel study that utilized open source technology in measuring jump performance. However, certain limitations should be noted. First, jump performance was measured using a trained population. Also, other kinematic variables and jump tests in Chronojump-Boscosystem were not used. Future studies undertaking these limitations should be warranted. In conclusion, CMJ FT, JH and DJ FT, JH are valid and useful measures in Chronojump-Boscosystem.

CONCLUSION

The low cost contact mat in this study is a valid device for vertical jump test. It provides good values of jump parameters during countermovement jump and drop jump tests. This device offers benefit regard to high utilization in sport field, handling, cost effectiveness and can display instantly information. Furthermore, the software is an open source software.

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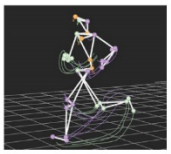
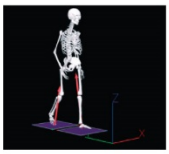
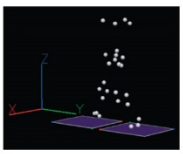

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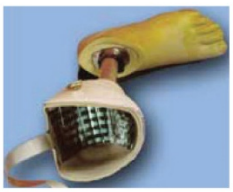
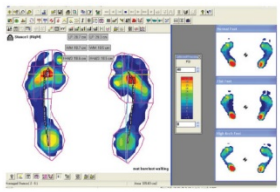

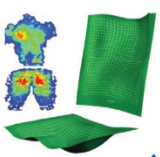

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