Journal of Sports Medicine & Doping Studies

ISSN: 2161-0673

Alshemimary et al., J Sports Med Doping Stud
2016, 6:2
DOI: 10.4172/2161-0673.1000182

Research Article Open Access

Between Days Reliability of 2D Video Analysis during Landing while Undertaking a Crossover Hop Test

Waleed K. Alshemimary[1*], Lee C. Herrington[2], Hussain S. Ghulam[2] and Fahad F. Aljowair[3]

[1]*Saudi Ministry of Health, Riyadh, Kingdom of Saudi Arabia*

[2]*University of Salford, United Kingdom*

[3]*Prince Sultan Military Medical City, Riyadh, Kingdom of Saudi Arabia*

[*]**Corresponding author:** Waleed K. Alshemimary, M.D, Physiotherapist at Saudi Ministry of Health- Riyadh -Kingdom of Saudi Arabia, Tel: +966 11 2125555; E-mail: w.k.alshemimary@edu.salford.ac.uk

Received date: April 11, 2016; **Accepted date:** June 04, 2016; **Published date:** June 10, 2016

Abstract

The Crossover Hop Test is a Functional Performance Test (FPT), which is used to demonstrate the leg muscles strength and performance, and evaluate symmetry between lower limbs, while evaluating the hop distance. Hop tests have been shown to be reliable for both injured and active subjects. The current study aims to establish the between days reliability of 2-Dimensional (2D) video analysis measuring knee valgus angles (frontal plane projection angle; FPPA) during each landing whilst undertaking a crossover hop test. Nine recreational male athletes (age 33.89 ± 3.96, height 170 ± 8.59 cm, weight 86.94 ± 20.86 kg) participated in the experiment. Each individual performed three repetitions of the cross over hop test, for both legs, and then repeated the same test seven days later. Results showed from the four landings that the first and third, for both legs demonstrated excellent Intraclass Correlation Coefficient (ICC) values for FPPA between days, while good to excellent ICC values for FPPA of the second landing and moderate ICC values for FPPA for the fourth. Standard Error Measurement (SEM) scores ranged from 1.04° to 2.42° for the right FPPA during the four landings, while the range of SEM values for the left FPPA were from 0.82° to 2.08°. The landing strategy adopted by participants, as defined by FPPA, would appear to be consistent between sessions. Hence, researchers and clinicians will be able to use crossover hop tests, which incorporate 2D video analysis, to assess simultaneously the limbs' performance functionality and the valgus angle of the knee. Therefore, this will save the athletes' and researchers' time, which will subsequently reduce the amount of fatigue resulting from over testing.

Keywords: Knee valgus; FPT; 2D reliability

Introduction

It has been documented that a variety of different knee injuries, including anterior cruciate ligament (ACL) injuries, have been caused through a direct linkage to the valgus or abducted position of the knee [1,2]. A significant injury risk has also been related to the patella femoral joint, when the knee valgus angles become increased [3]. Hence, it has been viewed as necessary to assess the knee valgus angle by using one of several screening tests in the research literature. For instance, this has included the tasks of drop landing [4], the drop vertical jump [2,5,6], the single-leg squat (SLS) [3,7], and the single-leg landing (SLL) [8].

The majority of these studies have used 3 -dimensional (3D) motion analysis to measure the biomechanics of lower limbs, which are generally perceived to be the gold standard for this form of experiment. Alternately, the analysis through 2D video, to quantify the nature of the knee valgus angle in athletes, as well as the general population (whether injured or not), has also been previously used during SLS, SLL [6,7], the drop vertical jump and step landing tasks [9,10]. Furthermore, 2D video analysis may be advantageous in athletics' training evaluation and active programs of intervention, which will assist frontal-plane dynamic knee valgus reduction. This is due to 2D video analysis is easy to use, portable and cheaper than 3D motion analysis [10].

A crossover hop test is an individual form of the FPT, which is frequently implemented in both clinical and field environments in order to detail athletes' progression in training programs, as well as to measure recovery levels for post-lower limb injury or surgery [11]. Munro and Herrington [11] previously reported excellent reliability of the distance jumped during the test. No study has presented data on the landing strategy (knee valgus angle) adopted during these tests. So it would appear an investigation into the reliability of knee valgus angle measurements (FPPA) during a crossover hop test using a 2D video analysis could be pertinent, to begin to understand landing strategy during this frequently used FPT.

The establishing of this screening method's reliability will permit both practicing clinicians and researchers to confidently administer the crossover hop test as a proven technique to assess knee valgus angles, alongside measuring the functional performance. Subsequently, this single-test development will save both athletes and researchers time, as well as reduce the amount of fatigue resulting from unnecessary over testing. The aim of the study is to measure the consistency of landing strategy (FPPA) whilst undertaking the cross over hop across two separate sessions.

Methods

The current study was formulated to establish the between days reliability of 2D video analysis in providing knee valgus angle measurements during a crossover hop test.

Subjects

Nine recreational male athletes (age 33.89 ± 3.96, height 170 ± 8.59 cm, weight 86.94 ± 20.86 kg) participated voluntarily in the study, and they were all current students at university. It was a prerequisite for participation that participants were injury free in the six month period prior to the study, and have also never had any lower limb surgery. The participants had to be recreational athletes, who are defined as those who participate in physical activity for at least 30 minutes, three times a week. In addition, each individual had to provide written consent before joining the experiment, which was then approved by the Research and Ethics Committee at the University of Salford.

Procedures

For each participant, measurements were separately taken on both legs during the performance of crossover hop tests, through the use of a 2D video analysis. In order to establish the between days reliability, subjects were asked to repeat the same test seven days later [12,13]. To avoid any differences that may occur as a result of different shoes, participants were instructed to wear the exact footwear from the previous time they attended [12]. Additionally, each participants was informed not to undertake any form of exercise during the pre-24 hour period to the crossover hop test, as well as refraining from eating or drinking in the hour prior to the test [12].

Markers were attached prior to the commencement of the testing procedure to both legs of each participant. The same researcher placed all the markers on the participants. Markers were placed at the midpoint of the femoral condyles to approximate the center of the knee joint, midpoint of the ankle malleoli for the center of the ankle joint, and on the proximal thigh along a line from the anterior superior iliac spine to the knee marker. The midpoints were determined using a standard tape measure, and all markers were placed by the same experimenter. These markers were used in order for FPPA of the knee to be determined from digital images using Quintic software package (9.03 version 17).

All the participating individuals were instructed to perform 3 practice trial repetitions on both legs in order to become accustomed to the test. Following this, they performed 3 recorded trials for both legs. To record the test, a digital video camera (Sony Handycam DCR-HC37) was aligned to the level of the participant's knee, with the positioning being 2.5 m from the final practice trial landing mark, and set on a perpendicular axis in relation to the frontal plane of the knee. The track was encoded for every single meter and the calibration was done in each encoded meter by using a calibration frame sized (1 m × 1 m) to ensure that every individual landing was applied within the calibrated area (Figure 1).

Participants were asked to stand on the test limb, facing the video camera, and then requested to hop forward 4 times, alternately crossing the 15-cm-wide line and landing on same limb (as illustrated in Figure 2 for the right leg). This procedure was repeated by each individual 3 times for each leg, with a full one minute recovery period in between demonstrations. Subsequently, the mean score of the maximum knee valgus angle were calculated for each leg, as well as the maximum crossover hop distance being measured through the use of a tape measure. Therefore, from the findings, the mean value of the participant's knee valgus angle value from all three trials was formatted for the experimental analysis. Likewise, an ICC value was formed from the between days reliability of this method.

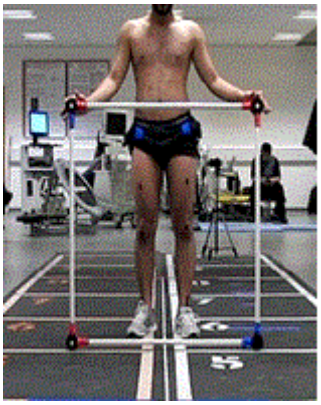

Figure 1: Illustration of calibration method.

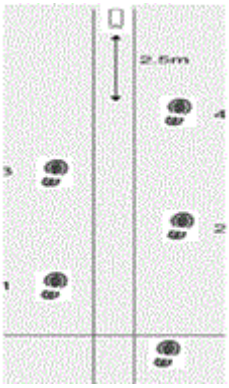

Figure 2: Illustration of Crossover hop test.

Statistical analysis

The SPSS of Windows 16.0 (SPSS Inc, Chicago, IL) was utilized for statistical analysis. In order to assess the relative and absolute reliability, the ICC model (3,k) was used in conjunction with the SEM as well as Confidence Intervals, with a significance value of $P < 0.05$. The ICC classification that was formulated to documents the value ranges were as follows: poor = 0.4 or less, fair to good = 0.4-0.75; excellent = exceeding 0.75 [14]. The SEM was obtained by taking the square root of the mean square error from the analysis of variance.

Results

Table 1 presents the statistics for the participants' knee valgus angles mean recordings, which were documented during performing the crossover hop test. Table 2 highlights ICCs with 95% CI means, and SEM values for each individual landing of both legs during the undertaking of the crossover hop test. Firstly, between days ICC values measured for the initial landing were excellent during the test (ICC_{RT} = 0.943; ICC_{LT} = 0.952). Secondly, that table showed excellent ICCs for the second landing of the right leg, while it was remarked as 'fair to good' in the second left leg landing. Thirdly, the third landing for both legs reported excellent ICCs. Finally, one of the expected results was that moderate ICCs during the fourth landing for both legs, which were the final landing during the crossover hop test. In addition, SEM

values can also be seen in Table 2, and ranged from 1.04° to 2.42° for the right knee valgus through the four landings, while the range of SEM values for the left knee valgus was from 0.82° to 2.08°.

	1st landing		2nd landing		3rd landing		4th landing	
	RT	LT	RT	LT	RT	LT	RT	LT
Mean	18.41	8.57	9.32	6.07	18.82	9.25	9.51	8.22
SD	7.28	6.32	4.99	2.78	5.88	6.03	3.71	3.46
MAX	33.16	24.61	18.85	9.76	29.06	19.61	16.95	13.8
MIN	9	3.47	3.04	2.06	10.38	1.83	3.99	3.91

Table 1: Average knee valgus during cross over test.

Variables	Between-days ICC (95% CI) Absolute agreement	Mean	SEM
RT knee valgus (1st landing)	0.94 (0.61 to 0.99)	18.41	2.42
RT knee valgus (2nd landing)	0.86 (0.44 to 0.97)	9.32	1.56
RT knee valgus (3rd landing)	0.81 (0.2 to 0.96)	18.82	1.83
RT knee valgus (4th landing)	0.51 (0.24 to 0.88)	9.51	1.04
LT knee valgus (1st landing)	0.95 (0.78 to 0.99)	8.57	2.08
LT knee valgus (2nd landing)	0.69 (0.25 to 0.93)	6.07	0.82
LT knee valgus (3rd landing)	0.86 (0.40 to 0.97)	9.25	1.9
LT knee valgus (4t landing)	0.59 (0.23 to 0.91)	8.22	0.96

Table 2: Between days ICC, Mean, and SEM values for 2D variables during cross over hop test.

Discussion

The dynamic knee valgus during common athletic tasks has been postulated as a risk factor for knee injuries [15,16], and can be assessed using a number of different screening tests [2,4,7,8]. The majority of previous investigations have recorded and assessed the lower limb kinematics through a 3D video. However, recent studies have started to incorporate 2D video analysis, due to its availability and ease of use [10]. The validity of 2D video analysis assessment for FPPA, compared with 3D analysis, has previously been established [3,17] so the method does provide a viable alternative. There has been a lack of the reliability data from 2D video analysis when measuring variables, such as the knee valgus angle during a horizontal hop for distance, and in the crossover hop test, despite them forming the core of many return to sport criteria.

The current study's principle objective has been to evaluate the between days reliability of 2D video analysis of FPPA on each of the 4 landings during crossover hop tests, with the analysis of FPPA being shown to be reliable by good or excellent ICC values. These results provide addition evidence about 2D video analysis reliability, the practical use of this method will be enhanced for the future.

The current study's findings highlight that moderate ICCs during the 4th landing for both legs, which were the final landing during the crossover hop test (ICC_{RT} = 0.51; ICC_{LT} = 0.59), showing that the FPPA during the final landing was the most inconsistent, this might be related to fatigue and requires further study. Similarly, the right leg showed noticeably increased FPPA on the 1st and 3rd landings, this may relate to poor control of motion in that particularly direction by that limb, again this requires further study to clarify the exact reasons.

It remains unclear whether age or participant's degree of physical fitness can influence FPPA. Thus, the findings may not be transferrable between professional competing athletes, injured individuals, or to differentiate between adolescents and older people, which creates the necessity for continual research through different populations.

Practical Applications

Most of previous studies measuring knee valgus angle (FPPA) involved several types of tests or landing tasks. This is the first study to assess FPPA during landing whilst undertaking a frequently used FPT such as crosses over hop. The strong reliability and relatively low SEM may make it possible for researchers to use one task, such as a crossover hop test to assess knee valgus angles and the functional performance at the same time, which will ultimately save athletes and researcher's time, as well as create fatigue reduction from over testing.

References

1. Hewett T, Lindenfeld T, Riccobene J, Noyes F (1999) The effect of neuromuscular training on the incidence of knee injury in female athletes. A prospective study. Am J Sports Med 27: 699-706.
2. Hewett T, Myer G, Ford K, Heidt R, Colosimo A, et al. (2005) Biomechanical measures of neuromuscular control and valgus loading of the knee predict anterior cruciate ligament injury risk in female athletes: A prospective study. Am J Sports Med 33: 492–501.
3. Willson J and Davis I (2008) Utility of frontal plane projection angle in females with patellofemoral pain. J Orthop Sports Phys Ther 38: 606–615.
4. Decker MJ, Torry MR, Wyland DJ, Sterett WI, Richard Steadman J (2003) Gender differences in lower extremity kinematics, kinetics and energy absorption during landing. Clin Biomech (Bristol, Avon) 18: 662–669.
5. Herrington L and Munro A (2010) Drop jump landing knee valgus angle; normative data in a physically active population. Phys Ther Sport 11: 56-59.
6. Noyes FR, Barber SD, Fleckenstein C, Walsh C, West J (2005) The drop-jump screening test: difference in lower limb control by gender and effect of neuromuscular training in female athletes. Am J Sports Med 33: 197–207.
7. Willson JD, Ireland ML, Davis I (2006) Core strength and lower extremity alignment during single leg squats. Med Sci Sports Exerc 38: 945–952.
8. Lawrence RK, Kernozek TW, Miller EJ, Torry MR, Reuteman P (2008) Influences of hip external rotation strength on knee mechanics during single-leg drop landings in females. Clin Biomech (Bristol, Avon) 23: 806–813.
9. Herrington, L (2011) Knee valgus angle during landing tasks in female volleyball and basketball players. J Strength Cond Res 25: 262–266.
10. Munro A, Herrington L, Carolan M (2012) Reliability of two-dimensional video assessment of frontal plane dynamic knee valgus during common athletic screening tasks. J Sport Rehabil 21: 7-11.
11. Reid A, Birmingham TB, Stratford PW, Alcock GK, Giffin JR (2007) Hop testing provides a reliable and valid outcome measure during rehabilitation after anterior cruciate ligament reconstruction. Phys Ther 87: 337–349.
12. Munro A and Herrington L (2011) Between-session reliability of four hop tests and the agility T-test. J Strength Cond Res 25: 1470-1477.
13. Maffiuletti NA, Bizzini M, Desbrosses K, Babault N, Munzinger U (2007) Reliability of knee extension and flexion measurements using the Con-Trex isokinetic dynamometer. clin physiol funct imaging 27: 346-353.

14. Fleiss JL (1986) The design and analysis of clinical experiments. New York, NY: Wiley.
15. Ireland ML (1999) Anterior cruciate ligament injury in female athletes: epidemiology. J Athl Train 34: 150–154.
16. Souza RB and Powers CM (2009) Differences in hip kinematics, muscle strength, and muscle activation between subjects with and without patellofemoral pain. J Orthop Sports Phys Ther 39: 12–19.
17. McLean SG, Walker K, Ford KR, Myer GD, Hewett TE, et al. (2005) Evaluation of a two dimensional analysis method as a screening and evaluation tool for anterior cruciate ligament injury. Br J Sports Med 39: 355–362.