A COMPARSION OF METHODS TO EXAMINE DOUBLE AND SINGLE LEG DROP JUMP PERFORMANCE

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The purpose of this study was to compare the use of both a force platform and Optojump photocell system (Microgate, Bolzano, Italy) to examine double leg and single leg drop jumps. Thirteen physically active individuals performed 5 double leg drop jumps and 5 single leg drop jumps from a height of 0.3 m. Ground contact time (CT), flight height (FH) and reactive strength index (RSI) were calculated concurrently for both jump types. Despite intraclass correlation coefficients for all variables being very close to 1, a significant systematic difference was consistently observed between both devices with the Optojump system overestimating CT and underestimating both FH and RSI for both jump types. Both devices demonstrated excellent test- retest reliability with all ICCs for CT, FH and RSI above 0.940.

KEY WORDS: force platform, Optojump, reactive strength index, reliability.

INTRODUCTION: Vertical jump testing is commonly used by researchers and coaches as a means of assessing lower body power and effective force production in jumping. The drop jump or depth jump is a plyometric exercise where an individual drops from a set box height and immediately upon landing performs a maximal effort vertical jump (Bobbert, 1990). This can be performed with both legs or with a single leg and has been widely used to assess an individual's jumping ability and reactive strength. The reactive strength index (RSI) is a measure of an individual's ability to change from an eccentric contraction to a concentric contraction (Young, 1995) and has been widely studied because of its association to performance and ability to identify individual limb differences (Flanagan, Galvin & Harrison, 2008). Various technologies have been used to examine drop jumps with a force platform system generally considered the gold standard for measuring temporal variables such as contact time and flight time along with outcome variables (i.e. flight height and RSI). Recent research has validated the use of a relatively less expensive device i.e. the Optojump system of photoelectric cells for estimating flight time and flight heights of countermovement jumps and squat jumps (Glatthorn *et al*, 2011). However despite the relevance of drop jump to sports performance, the effectiveness of Optojump and force platform systems in evaluating drop jump parameters has not been compared. The aim of this study was therefore to compare both force platform and Optojump systems in the assessment of contact time, flight time, flight height and RSI for double leg and single leg drop jumps.

METHODS: Following ethical approval by the local University Research Ethics Committee thirteen subjects were recruited for this study. All participants were physically active males: (n=7); age: 22 ± 3.3 years; height; 1.78 ± 0.05 m; body mass 73.8 ± 6.1 kg and females: (n=6); age: 24.8 ± 2.1 years; height; 1.71 ± 0.06 m; body mass 68.2 ± 6.2 kg (mean ± SD) and were free of any injuries at the time of testing. All subjects were familiar with double leg and single leg drop jumps. The Optojump photoelectric cells (Microgate, Bolzano, Italy) were set up alongside dual AMTI OR6-5 force platforms operating at 1,000 Hz so that all jumps could be assessed by both devices concurrently. Subjects performed a standardised warm up consisting of 3 minutes of running at a self-selected, comfortable pace followed by 2 sets of 10 dynamic stretches (forward and sideways hip swings, bodyweight squats, lunges) and submaximal attempts at double leg and single leg drop jumps. After the standardised warm up, subjects performed 5 double leg drop jumps and 5 single leg drop jump on their dominant leg only with the best 3 jumps each selected for analysis. All jumps were performed from a box height of 0.3 m. Strict instructions were given to each subject on the technique of all jumps i.e. hands to be kept on hips at all times, no tucking motion in the air and the aim of the jump is to minimise contact time while also attempting to achieve maximal height (Young, Pryor and Wilson, 1995). A rest period of 30 seconds was given between trials of the same jump type with 3 minutes rest given between jump types to avoid any residual effects of fatigue on performance (Read & Cisar, 2001). The dependent variables calculated for both jump types were: ground contact time (CT), flight height (FH) and reactive strength index (RSI). CTs and flight times (FT) were obtained directly from the force platform data. FH was estimated using the second mathematical equation of linear motion i.e. $s = ut + ½at^2$ where $a = 9.81\ m.s^{-2}$ and $t = FT/2$. CTs and FTs were automatically output by the Optojump system after each jump. RSI was calculated as the flight height in metres divided by the contact time in seconds (Young, 1995). Force platform and Optojump methods were compared using Bland-Altman systematic bias ± random error (Bland & Altman, 1986) and intraclass correlation coefficients (ICCs) with 95% confidence intervals (CI) (Atkinson & Nevill, 1998). Relative reliability was also investigated for both instruments using ICC with 95% CI.

RESULTS: The mean results (± SD) and ranges for all variables for double leg and single leg drop jumps are given in Tables 1 and 2 respectively. Although the between instrument ICCs were all close to 1 for double leg drop jump (CT; 0.999, FH; 0.998, RSI; 0.997) and single leg drop jump (CT; 0.996, FH; 0.997, RSI; 0.994) a significant systematic bias was observed between force platform and Optojump measures (Tables 1 and 2). The greatest percentage difference between methods was found for RSI with a 4.38% and a 6.98% difference found for double leg and single leg drop jumps respectively. Bland-Altman plots are illustrated in Figure 1 for RSI for both jump types. ICCs for relative reliability for both instruments were all close to 1 and given in Table 3.

Table 1: Comparison of force platform and Optojump for double leg drop jump (Mean values ±SD with Range)

	CT (ms)	FH (m)	RSI (m/s)
Force Plate (95% CI)	0.257 ± 0.074 (0.174 – 0.467)	0.267 ± 0.066 (0.115 – 0.375)	1.15 ± 0.46 (0.30 – 1.85)
Optojump (95% CI)	0.261 ± 0.074 (0.177 – 0.470)	0.262 ± 0.065 (0.110 – 0.367)	1.10 ± 0.44 (0.28 – 1.79)
% Difference	1.56	1.87	4.38
Systematic Bias	-0.004	0.005	0.05

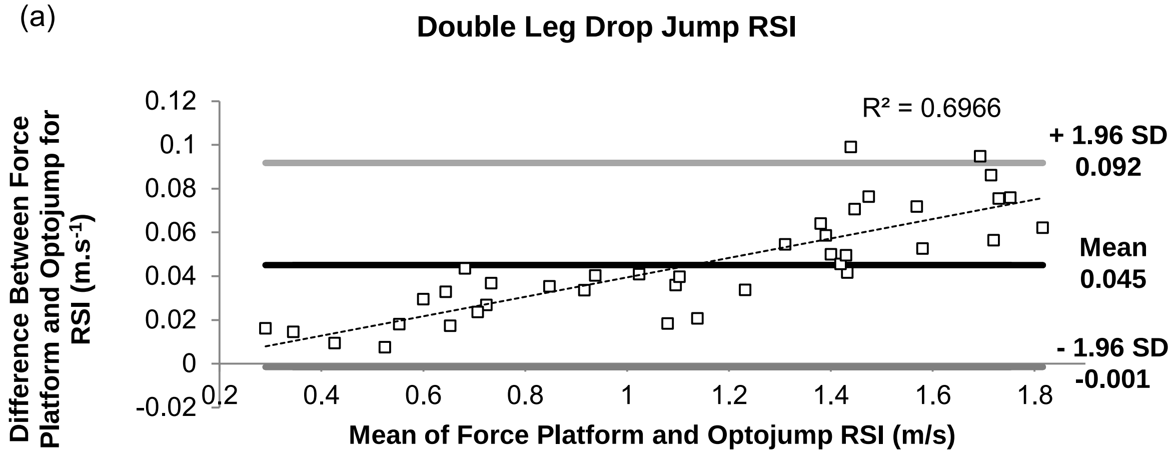
Table 2: Comparison of force platform and Optojump for single leg drop jump (Mean values ±SD with Range)

	CT (ms)	FH (m)	RSI (m/s)
Force Plate (95% CI)	0.299 ± 0.046 (0.228 – 0.416)	0.125 ± 0.046 (0.050 – 0.243)	0.43 ± 0.18 (0.19 – 0.91)
Optojump (95% CI)	0.305 ± 0.048 (0.231 – 0.421)	0.120 ± 0.045 (0.047 – 0.236)	0.40 ± 0.17 (0.17 – 0.87)
% Difference	2.00	4.00	6.98
Systematic Bias	-0.006	0.005	0.02

Table 3: Intraclass Correlation Coefficients for CT, FH and RSI for the double and single leg drop jumps measured by force platform and Optojump.

	Double Leg Drop Jump			Single Leg Drop Jump		
	CT	FH	RSI	CT	FH	RSI
Force Platform	0.974	0.971	0.990	0.976	0.945	0.960
Optojump	0.973	0.972	0.989	0.976	0.942	0.957

(a)



(b)

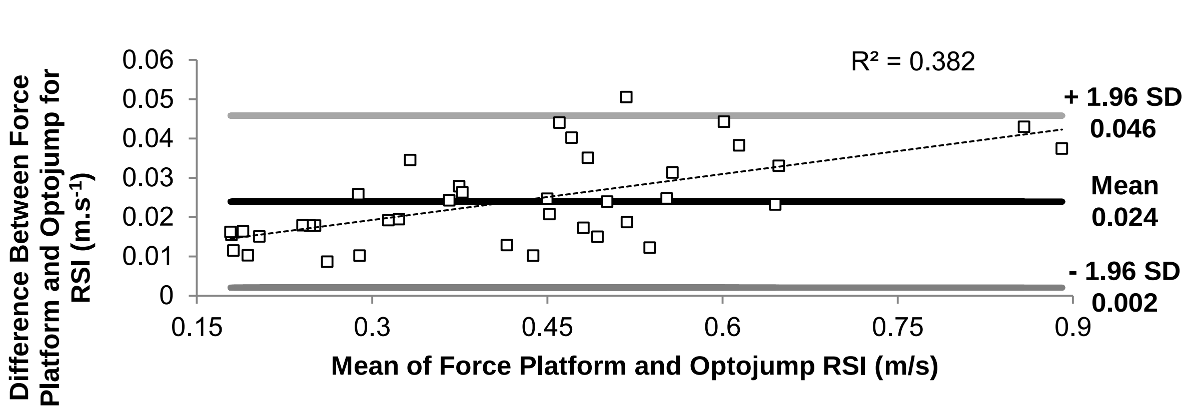


Figure 1: Bland and Altman plot (n=39) of Force Platform and Optojump RSI for (a) double leg drop jump and (b) single leg drop jump.

DISCUSSION: The main findings of this study were that the Optojump photoelectric cells consistently overestimated CT and underestimated both FH and RSI for double leg and single leg drop jumps compared to force platform measures. This is consistent with previous research which reported a systematic underestimation of approximately 2.5% in flight height during countermovement and squat jumps (Glatthorn *et al*, 2011). This difference can be explained by the physical set up of the Optojump as the transmitter is positioned 0.3 cm from ground level i.e. the surface of the force plate. This would result in the transmitter detecting the initiation of contact time before the foot is in contact with the force plate and a delay in the detection of flight time until the individual's feet pass the 0.3 cm high photoelectric cells. The largest difference between devices can be seen for RSI (4.38-6.98%) as the calculation of RSI requires CT and FH which is derived from FT. A greater CT and a lower FT would combine to yield a lower RSI compared to force platform measures. The R^2 values and regression line in Figure 1 illustrate a positive slope which suggests that that the differences between the systems are proportional to the size of the calculated RSI. Both instruments demonstrated excellent test-retest reliability with ICCs for all variables between 0.942 - 0.990. This suggests that practitioners can reliably use the portable and relatively less expensive Optojump system for assessing temporal and outcome measures of double leg and single leg drop jumps in the field.

CONCLUSION: A consistent systematic difference exists between devices due to the physical set up of the Optojump photocell system which results in an overestimation of contact time and an underestimation of both flight height and reactive strength index in comparison to the force platform. This underestimation increases proportionally to an increase in calculated RSI. The force platform and Optojump photocell system should not be used interchangeably for calculating contact time, flight height and RSI for the double leg drop jump and the single leg drop jump. Both the force platform and the Optojump devices can both measure performance variables for double leg and single leg drop jumps with very high test-retest reliability suggesting that the Optojump system is a perfectly viable option and a more convenient method of assessing drop jumps in a field based setting.

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