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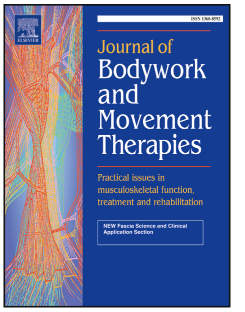

Unilateral dynamic balance assessment: The test-retest reliability of the OptoJump next drift protocol

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Unilateral dynamic balance assessment: the test-retest reliability of the OptoJump Next Drift Protocol

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Abstract

Background: The OptoJump Next Drift Protocol is a test designed to assess unilateral dynamic balance. Participants are required to perform a series of unilateral jumps from which left/right and forward/back displacement (Drift) is calculated.

Objectives: This investigation set out to establish the test-retest reliability of the OptoJump Next Drift Protocol.

Method: Twenty-six participants performed the OptoJump Next Drift Protocol on two separate occasions. Drift Area and Drift Area as a percentage of total available jump area were calculated for each leg.

Results: Interclass Correlation Coefficients (ICC) indicated poor reliability for Drift Area and Drift Area as a percentage of total available jump area (right leg r = .44; left leg r = -.20). However, 95% Limits of Agreement (LoA) suggested a stronger relationship. For Drift Area, between trial Mean Difference for the right leg was 50.87 cm^2 (95% LoA = -227.57 – 328.87) and for the left leg it was 54.08 cm^2 (95% LoA = -333.62 – 441.79). For Drift Area as a percentage of total available jump area, Mean Difference for the right leg was .56% (95% LoA = -2.44 – 3.65) and for left .60% (95% LoA = - 3.76 – 4.89).

Conclusions: Based on the 95% LoA data, the authors suggest that the OptoJump Next Drift Protocol does offer an acceptable level of reliability.

Keywords: Dynamic Balance, Sport Performance, Injury

Introduction

Dynamic balance refers to the ability to control the centre of mass and base of support during motion (Gadzic et al., 2022). It encompasses the performance of physical tasks while maintaining a stable position and/or the regaining of balance with minimal extraneous movement (Hrysomallis, 2011). Dynamic balance is an integrated skill that includes the processing of somatosensory, visual, and vestibular sensory information (Ricotti, 2011) as well as physical attributes such as flexibility and strength (Bressel et al., 2007). Dynamic balance is considered an inherent component of most sporting activities and as such, its development is vitally important (Hrysomallis, 2011). This is particularly so for unilateral dynamic balance, which is essential for changing direction and single leg jumping and landing (Barrera-Domínguez et al., 2021). Whilst specific research examining the impact of dynamic balance on athletic performance is limited, there is some evidence to suggest a positive relationship between the two (Hrysomallis, 2011; Kummel et al., 2016). For example, Hrysomallis (2011) found levels of dynamic balance in elite athletes (soccer and ice hockey players) to be superior to those of their non-elite counterparts. Dynamic balance has also been implicated in non-contact lower limb injury (McGuine et al., 2000; Plisky et al., 2006; Hrysomallis, 2007; Butler et al., 2013; de Noronha et al., 2013). Buter et al. (2013) showed college football players with poor levels of dynamic balance to be more suspectable to knee and ankle injuries. Similarly, studying a sample of physically active participants over a one-year period, de Noronha et al. (2013) reported an elevated risk of ankle sprains in those with low levels of dynamic balance. Dynamic balance screening might therefore aid in the identification of athletes who are more vulnerable to such trauma (Butler et al., 2013). In addition, it might also provide a means of monitoring lower limb injury rehabilitation progress (Hrysomallis, 2007).

There are numerous tests available for the assessment of balance. Centre of Pressure and Sway tests can be used to assess static balance, whilst the Star Excursion Balance Test (SEBT) and the Y-Balance Test are often utilised to measure dynamic actions (Hrysomallis, 2011). All of these can provide information regarding unilateral balance status. Whilst such methods are undoubtably useful given that they have been used to uncover the associations between balance, lower extremity injury, and athletic performance (Gribbel et al., 2012) they are not without issue. In particular, the legitimacy of such procedures for the assessment of dynamic balance has been questioned because the movements undertaken are somewhat static in nature (Hrysomallis, 2011; Gadzic et al., 2022). One test that does appear to measure this construct is the Optojump Next system Drift Protocol. This procedure requires participants to perform multiple single leg jumps during which mediolateral (left/right) and anteroposterior (forward/ back) displacement (Drift) are recorded. Drift area is indicative of dynamic balance; the greater displacement, the more deficient one is at the skill.

Whilst the Optojump Next system has been found to be valid when measuring movements such as vertical jump height (Glatthorn et al., 2011) and various gait parameters (Lee et al., 2014) there is limited information regarding the veracity of the Drift Protocol. In fact, to date there are only a few examples of its use within the research literature. Słomka et al. (2018) claim to have successfully used the protocol to evaluate the effectiveness of an 8-week complex balance training regime. The reductions in Drift Area observed over this period were interpreted as showing improvements in dynamic balance; although it must be noted that changes were only observed in the mediolateral plane. Gadzic et al. (2022) utilised the Drift Protocol to monitor rehabilitation from ACL reconstruction. Reductions in Drift Area were evident upon completion of the recovery process.

In summary, unilateral dynamic balance is an important requirement for athletic performance. It has also been implicated in injury risk. Given the potential of the OptoJump

Next Drift Protocol to identify unilateral dynamic balance status, efforts are required to determine the legitimacy of the procedure. Unfortunately, there is currently no verified Gold-Standard method of dynamic balance assessment and as such criterion-validity cannot be established. This investigation will therefore measure the reliability of the OptoJump Next Drift Protocol. If found to be reliable, recommendations regarding its suitability for the assessment of performance-based dynamic balance and injury screening will be made.

Methods

Participants

In total, thirty-eight participants were recruited for the study. However, eight failed to attend both testing sessions. An additional four were omitted because they could not safely perform the procedure. Hence, the analysis was conducted on a total of twenty-six participants (seventeen males and nine females: *M*age = 21.24 yrs. ± 4.15, *M*height = 173.75 cm ± 8.47, *M*weight = 73.61 kg ± 14.76). All were right leg dominant. The participants were sport students enrolled at university located in the North West of England. The decision to use sports students benefits the investigation since the Optojump Next Drift Protocol aims to qualify dynamic balance in athletes and as such, the use of a physically active individuals acts as a representative sample. In addition, the actions required during the procedure are maximal effort. Employing participants who are accustomed to such movements should improve the validity of the investigation and reduce injury risk. All participants were required to complete an MSK injury screening survey and confirm that they were injury free prior to participation. The study was approved by the Institutional ethics committee (ref. 22/xx).

Dynamic Balance

DYNAMIC BALANCE

This was assessed using the Drift Protocol included within the test battery of the OptoJump Next System (Microgate, Italy). The basic Optojump unit consists of a transmitter and receiver bar. Each bar is 1m in length and contains 96 LEDs thus providing a resolution of 1.0416cm. The study adopted the standard Drift Protocol that involves the transmitter and receiver bars being placed in a parallel configuration. Participants are required to perform twenty single-leg jumps (ten on each leg) to establish mediolateral (left/right) and anteroposterior (forward/back) displacement. There is little information provided by the manufacturer regarding a specific jumping technique. Therefore, for the current investigation all jumps were performed following the protocol suggested by Slomka et al. (2018). Specifically, each participant elevated their non-active foot to the knee height of the contralateral leg and kept it at this level during the jumps. Hands were maintained in the akimbo position whilst performing the actions.

Measures

The Optojump Next Drift Protocol provides data on unilateral jump height, power, foot contact time and average left/right and front/back Drift as well as Total Drift Area. For the purposes of the current investigation only jump height and Total Drift Area were analysed.

Procedures

Upon entering the testing venue measures of weight (kg), height (cm) and age (yr.) were obtained. A standardised 10-minute incremental warm-up was undertaken by all participants prior to engagement. This consisted of three, one-minute straight-line runs progressing from RPE 9 (very-light) to RPE 13 (somewhat-hard). Each was interspersed with practice jumps beginning with ten double-legged jumps at 50% perceived maximal power and progressing to single-leg jumps at 70% of perceived maximal power. Upon completion of the warm-up the Drift protocol was introduced and demonstrations of the jump technique provided. Participants were instructed to stand directly on top of a marked position at the centre point of the jumping area and to take the appropriate stance. They then completed the test by performing the jumps at maximal effort (i.e., jump as high as you can). The transmitter and receiver bars are 100 cm in length and were positioned at 90 cm apart. Thus, there was a total available area of 9000 cm^2. Retesting was conducted seven days after the initial trials. Participants were evaluated individually and in isolation apart from a member of the research team. Jumps were monitored throughout, and data was discarded if (1) participants did not comply with the instructions provided (2) they strayed from the permitted jump area or (3) the movements were deemed dangerous. To increase intertrial consistency, jumps were performed without footwear to avoid any potential effects of shoe design (e.g., heel height, cushioning, torsion bars) on ankle stability and balance (Robbins et al., 1994).

Data analysis strategy

Normality checks were performed by calculating z-scores (dividing the skew and kurtosis values by their standard errors). All data was deemed to be normally distributed. Reliability was assessed using Interclass Correlation Coefficients (ICC) - Single Measurement, Two-Way Mixed effects, Absolute Agreement (Koo and Li, 2016) and Bland and Altman's (1986) Limits of Agreement (LoA). The LoA procedures were applied to both Drift Area (cm^2) and Drift Area as percentage of total available area (9000 cm^2). Analysis was conducted for both the right and left legs. Jump height data for each trial as recorded and Pearson's correlations were performed to determine if jump height impacted Drift Area. Sample size calculations using the recommendations of Bujang and Baharum (2017) suggested that the sample of twenty-six was adequate to detect ICC relationships at 80% power (1 – β).

Results

Drift Area and Interclass Correlation Coefficients (ICC)

For the right leg, Mean Drift Area was 152.11 cm^2 (*sd* = 135.09) for Trial 1 (T1) and 202.76 cm^2 (*sd* = 138.24) for Trial 2 (T2); ICC *r* = .44, 95% *CI* = .09 - .69, *p* = .00. For the left leg, Mean Drift Area was 158.75 cm^2 (*sd* = 128.0) for T1 and 212.83 cm^2 (*sd* = 126.15) for T2; ICC = -.20, 95% *CI* = -5.30 - .186, *p* = .85. Mean percentage of total area used for the right leg was 1.69% (*sd* =1.50) for T1 and 2.25% (*sd* = 1.53) for T2. Mean percentage of total area used for the left leg =1.76% (*sd* = 1.42) for T1 and 2.36% (*sd* = 1.40) for T2. The ICC outcomes reported above are also applicable to this data.

Limits of Agreement

Figures 1 and 2 show the Drift area for each leg. For the right leg, mean difference between the trials was 50.56 cm^2 (95% LoA = -227.57 cm^2 - 328.87 cm^2. For the left leg, mean difference was 54.08 cm^2 (95% LoA = -333.62 cm^2 - 441.79 cm^2). As a percentage of total available area used, for the right leg *M*percentage used = .56% (95% LoA = -2.44% - 3.56%) and for the left leg *M*percentage used = .60% (95% LoA = -3.76% - 4.89%) - see Figures 3 and 4.

ALL FIGURES PLACED HERE

Jump Height and Drift Correlations

Jump height for right leg T1 was *M* = 6.32cm (*sd* = 3.03) and T2, *M* = 5.54cm (*sd* = 2.71). The Pearson's Correlation Coefficient showed these the data to be highly correlated; *r* = .746, *p* = .00. Jump height for the left leg T1 was *M* = 6.31cm (*sd* = 2.91) and T2, *M* = 6.67cm (*sd* =3.09). Again, these were highly correlated; *r* = .85, *p* = .00. Pearson's Correlation Coefficients revealed a significant relationship between jump height and Drift Area for the right leg T2, *r* = .46, *p* =.02 and left leg T1, *r* = .56, *p* = .00. There were no significant relationships for right leg; T1, *r* = .19, *p* =.35 or left leg T2, *r* = .06, *p* =.75.

Discussion

Dynamic Balance, particularly unilateral, is not only vital for optimal sports performance (Hrysomallis, 2011) it is also implicated in lower extremity injury risk (McGuine et al., 2000; Hrysomallis, 2007; Butler et al., 2007). Whilst tests such as the SEBT and Y-Balance are often utilised to assess unilateral dynamic balance status (Hrysomallis, 2011), it is debatable as to whether such methods actually assess this construct given that the actions required are rather static in nature. A more appropriate assessment option might be the Optojump Next Drift Protocol as this procedure more closely reflects the dynamic nature of the movements required in sport. This investigation therefore aimed to evaluate the reliability of this protocol. For both Drift Area and Drift Area as a percentage of total available jump area the ICCs indicated 'poor' test-retest reliability for both limbs (Koo and Li, 2016); although the upper 95% CI for the right leg did reach 'moderate' strength. However, the 95% LoAs for both Drift Area and Drift Area as a percentage of total available area suggested a stronger relationship. This was particularly evident for Drift Area as a percentage of total available area where mean between trial differences were .56% and .60 % respectively for right and left Drift.

Whilst the 95% LoA outcomes do suggest an acceptable level of reliability, several factors need to be considered when interpreting these outcomes. First, our data shows that in general, participants did not jump particularly high. It is possible that employing a more powerful technique would impact dynamic balance. As Slomska et al., (2018) point out, the higher the jump the harder it is to control the body. Thus, more forceful actions are likely to increase Drift Area. The correlational analysis does provide some evidence to support such an assertion. However, the influence of jump height on reliability is unclear. Second, there were some instances where Drift Area appeared visually, to be greater than the values provided by the Optojump Next System. Whilst this observation cannot be confirmed, such discrepancies are possible as when used in the standard configuration, the Optojump Next Drift calculates mediolateral (left/right) and anteroposterior (forward/ back) displacement independently. As such, mediolateral movements are not detected during anteroposterior measurements and vice versa. To overcome this issue, the Optojump Next Drift does allow for a more advanced two-dimensional configuration. However, this option requires additional transmitter/receiver bars.

In summary, this is the first study to assess the reliability of the Optojump Next Drift Protocol. We argue that the 95% LoA data can be taken to indicate that when a specific jump protocol is implemented (see Methods section), the system can be used to assess unilateral dynamic balance. The current authors therefore suggest that the Optojump Next Drift Protocol can be used by coaches and physical trainers to assess dynamic balance status and to monitor training progression (Hrysomallis 2011). In addition, the protocol can be utilised for lower limb injury screening and by medical personnel to assess the effectiveness of lower limb rehabilitation programs. Given the unilateral nature of the test, it might also be useful for uncovering asymmetrical differences in dynamic balance that might also impact performance and injury risk (Barrera-Domínguez et al. 2021). However, the issues highlighted need to be taken into account by those utilising this testing procedure. As to whether the Optojump Next Drift Protocol should be considered superior to methods such as the SEBT and Y-Balance test, we would argue that it does provide a more ecologically valid option for the evaluation of dynamic balance. Test specificity is an important consideration when selecting assessment methods (Hrysomallis et al., 2006; Hrysomallis, 2011; Karimi and Solomonidis, 2011) and it is apparent that the actions required for the Optojump Next Drift Protocol more closely reflect those used in many sports. We nevertheless encourage further research to determine the influence of jump height reliability; this might be particularly relevant if assessing high-performance athletes. It might also be worthwhile to consider the feasibility of the Optojump Next Drift Protocol for use with the elderly given the link between balance and fall risk (Muir et al., 2013; Thomas et al., 2019). Lastly, investigations are also required to establish whether Drift outcomes do indeed impact sports performance and lower extremity injury.

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Figure 1 shows 95% LoA for right leg drift area (cm^2)

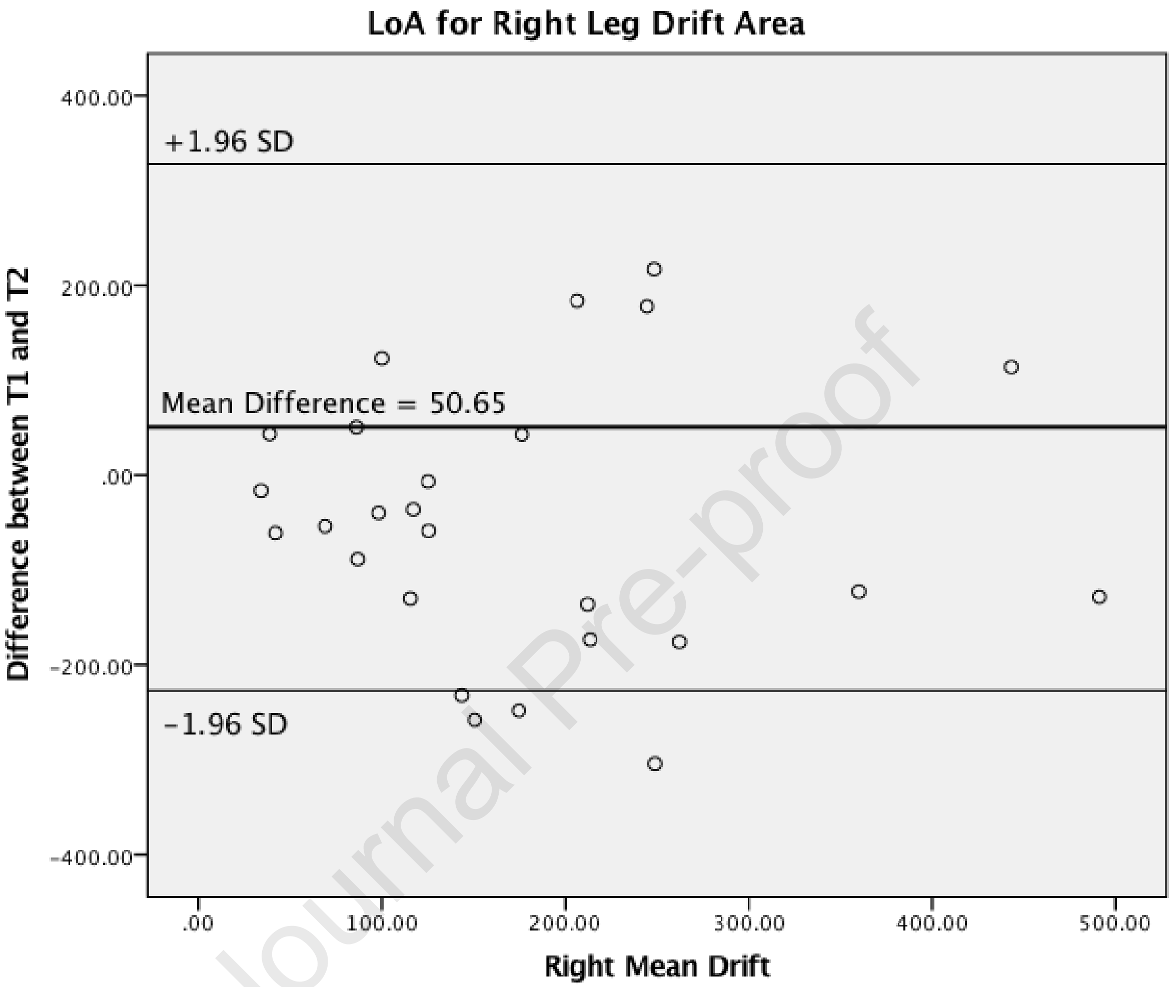

Figure 2 shows 95% LoA for light leg drift area (cm^2)

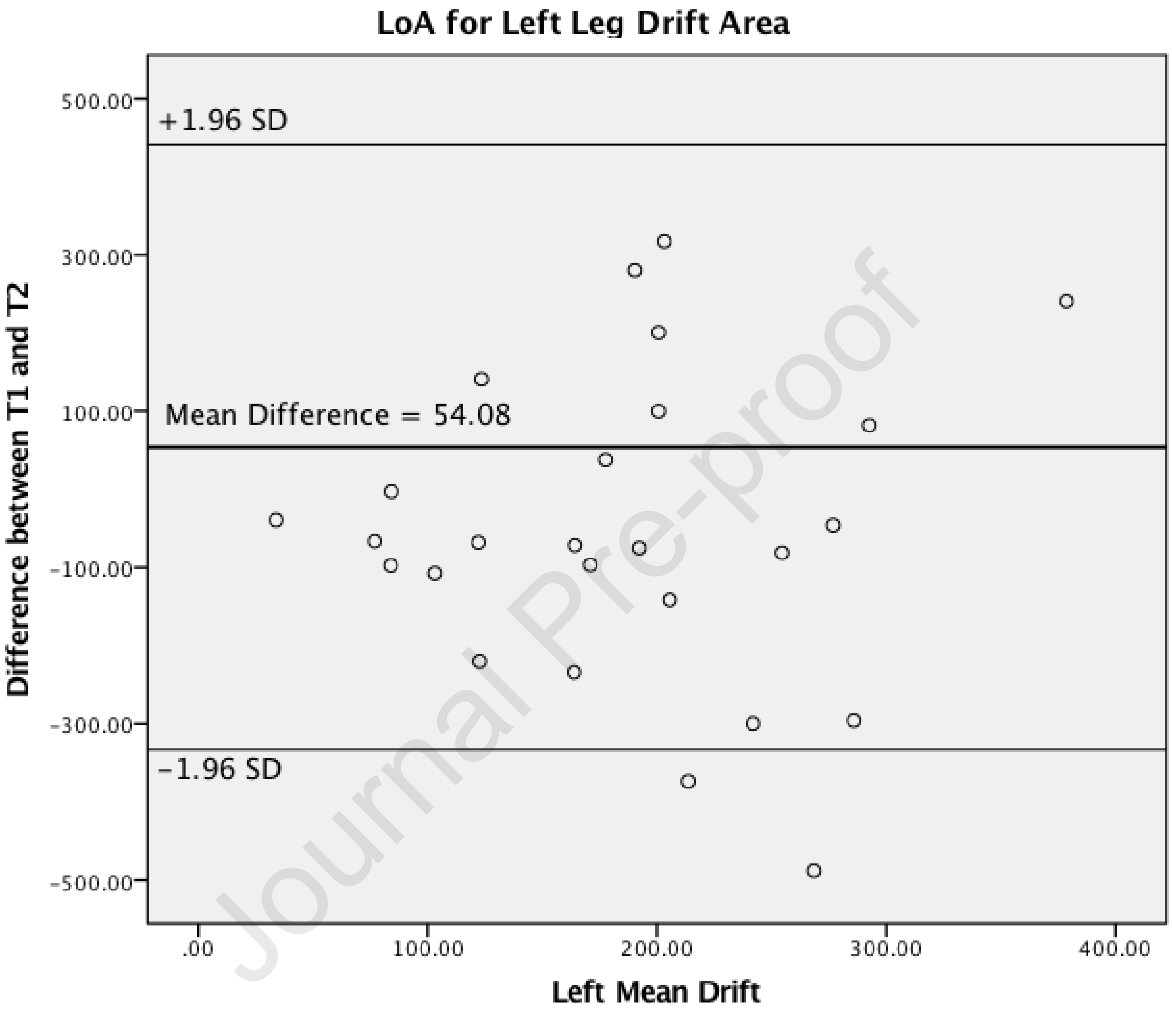

Figure 3 shows 95% LoA for right leg drift area as a percentage of total available jump area

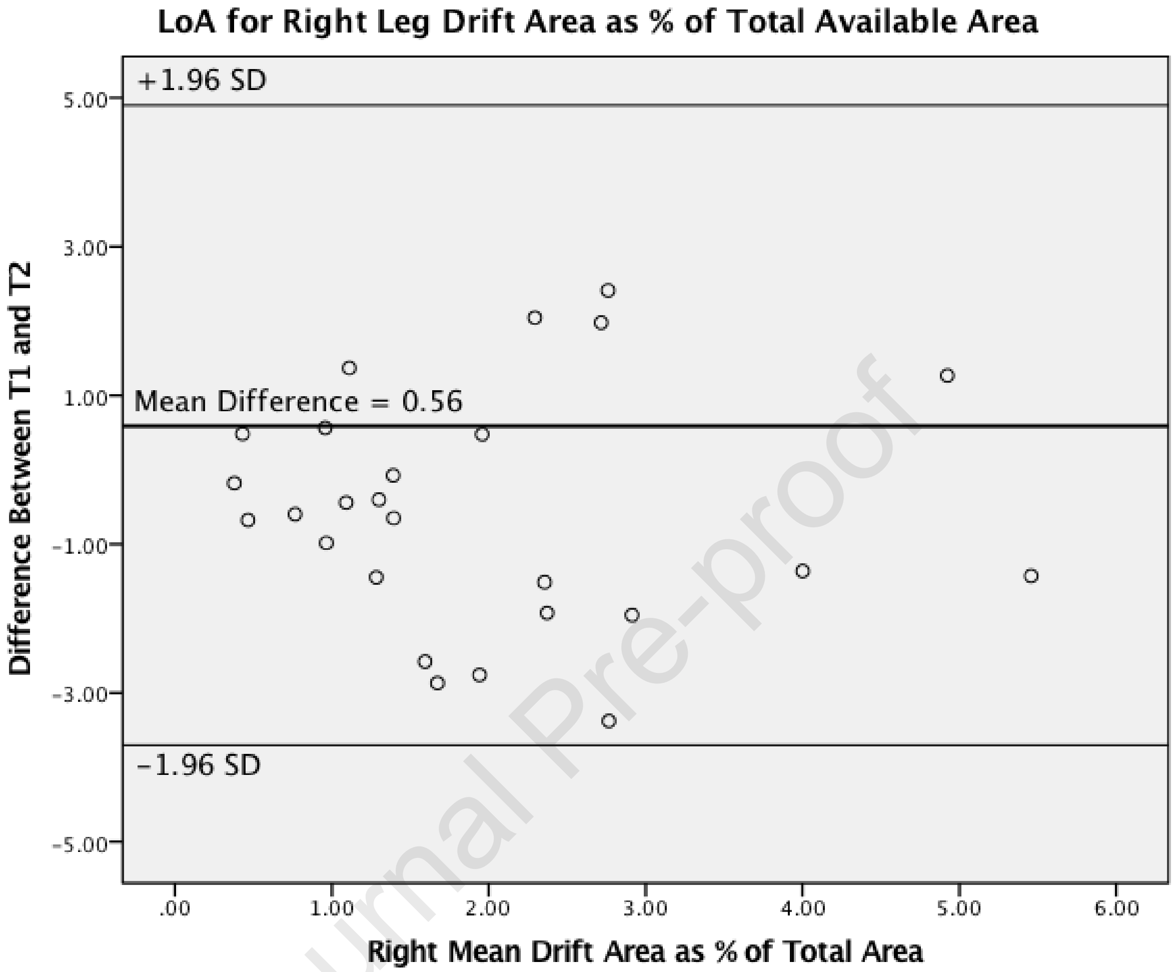

Figure 4 shows 95% LoA for light leg drift area as a percentage of total available jump area