THE DEVELOPMENT OF A NEW PROTOCOL TO ASSESS PERFORMANCE MEASURE IN SPORTS

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The purpose of this study was to develop a novel protocol to be used in assessing performance outcomes in projectile sports. This study also wanted to establish if variability within a movement pattern (throwing) is detrimental to the outcome of that skill and to assess the validity of current methods used to measure performance. Single subject analysis was undertaken as 4 Wilson Trainer™ tennis balls were launched using a Tennis Cube™ launcher at a wall 25 times each. Infra-red light gate technique (wall mounted Optojump™) in which ball tracking co-ordinates were obtained were compared to traditional movement measure device (3D Motion Analysis Corporation™) coordinates. Agreement between the 3D landing point X and Y coordinates and the OptojumpTM landing points X and Y coordinates were analysed using the Bland- Altman method.

KEY WORDS: comparison, Optojump™, performance measurement, projectiles.

INTRODUCTION: This paper focuses on the development of a novel protocol for assessing performance measurement in target sports. Sports such as archery and rifle shooting are generally scored in a manner where a numeric value is awarded the closer to the centre of the target the projectile hits. Previous research on archery has used the FITA (International Archery Federation) scores to measure performance (Soylu, Ertan & Korkusuz, 2006). By doing so this awards the athlete with a numeric value to quantify success or failure. Research in rifle shooting has used conventional air rifle targets (Mullineaux, Underwood, Shapiro & Hall, 2012) and in basketball researchers have developed scoring methods themselves where numerical values are awarded based on how "clean" a basket is achieved (3 marks) to a complete miss (0 marks).These performance measures although informing the athlete whether they were successful or not return little feedback on how the performance could be enhanced. Ganter, Matyshiok, Partie, Tesch and Edelmann-Nusser (2010) enhanced performance feedback by measuring performance by the FITA scoring system and simultaneously measuring the movement of the bow which showed good correlation and could be used in individual performance evaluation. Lin and Hwang (2005) investigated the length of aiming time in relation to shot points in archery and compared these results not with the FITA but with vertical, horizontal and radial deviation. Studies previous to this had found that there was a positive correlation between increased aiming time and shot points on target along the radial direction and this was confirmed in this study. Mullineaux et al. (2012) also used electronic targets (MEGAlink4k187) which registered shots using 4 microphones on the corners of the target. This gave a precise measurement of the shot location which was relayed back to a screen for the shooter to see. This gives them an arguably more valid performance outcome measure. These are some of the previous ways of assessing performance outcome however this study aims to use new technology to create a highly accurate and reliable new performance measurement instrument.

The Optojump™ has proved to be a valid method of measuring vertical jump height and has also been tested against the IR contact mat (Erotest™) for flight time and contact time (Bosquet, Berryman & Dupay, 2009) where results showed the two machines to be interchangeable. It has also been identified as the "Gold Standard" when comparing and testing other systems (Casartelli, Muller & Maffiuletti, 2010). Knowing Optojump™ is a valid measure will allow us to investigate whether when compared to MAC (Motion Analysis Corporation Ltd., Santa Rosa, California) the Optojump™ can produce accurate, reliable and easily-obtained results for assessing projectile throwing performance.

METHODS: Equipment: The Tennis Cube™ ball launcher was positioned on the ground at a distance of 4.25m from the wall (due to lab restrictions). It was placed at speed setting five of 10 (middle speed of the machine) and at a trajectory of two. This remained constant throughout testing. Weights were placed on either side of the machine and placed both in front and behind so as to combat vibrations and secure the launcher to the ground. Ten new Wilson Trainer™ tennis balls were weighed and their diameters were measured. Tennis balls which were outside the mass bracket of 56.0 – 59.4 grams (IFT standards) and were not 6.35cms in diameter (Wimbledon standards) were omitted from the study. Four tennis balls within the criteria were then chosen and each was wrapped with ten strips of 3M retro-reflective tape. Each strip was 21 cm long and 2.5 cm wide. Each tennis ball was wrapped in the same method for consistency. Six Digital Eagle Cameras (Motion Analysis Corporation Ltd., Santa Rosa, California) operating at 200hz were placed in a semi circle around a wall target at which the balls were launched. They collected information in 3 second sets. Optojump™ was mounted onto a wooden frame measuring 2 m x 2 m using Velcro placed on the underside of the Optojump™ bars. This was then placed vertically against the wall with the bottom left corner aligning with the origin of the L plate used in calibrating MAC™. The Optopjump™ was connected via USB to the laptop and the utility hardware test was executed in the Optojump™ Next Software for results. Protocols: Data collection was triggered via manual start for both 3D and Optojump™ for each trial. The 4 tennis balls were then fired 25 times each at the wall and movement coordinate data was collected for all. Optojump™ results were recorded manually after each trial. Data Analysis: Data were then analysed and discussed. 68 out of 100 trials were usable due to Optojump™ reading no light beams were disrupted or only one co-ordinate was given. These trials were omitted. The normal distribution of the data was tested using a Shapiro-Wilkes test. As recommended by Bland and Altman (1986) the comparison of methods was assessed by calculating the paired difference between the methods and the mean of the two methods. This was done for both the x coordinates (horizontal) (Figure 1) and the y coordinates (vertical) (Figure 2). The 95% limits of agreements and mean difference (bias) were also plotted. The solid line represents the bias, the dashed line represents the limits of agreement.

RESULTS: R^2 values of 0.327 for the x coordinates and 0.171 for the y coordinates were calculated.

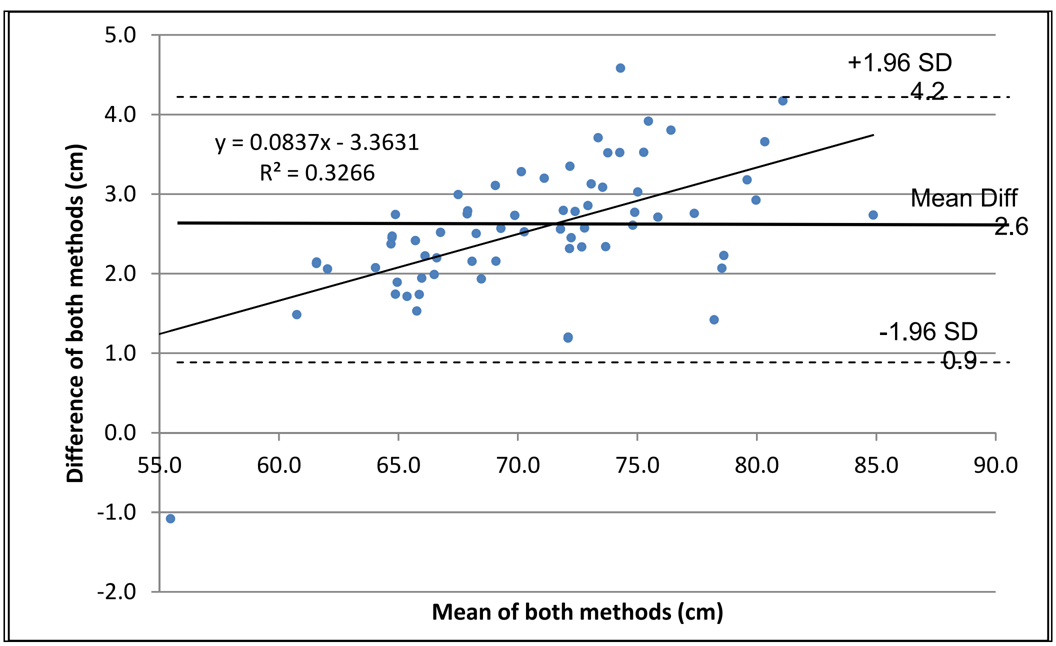

Figure 1. Bland and Altman plot of the X co-ordinates data obtained from 68 paired samples generated from the Motion Analysis Cameras and Optojump™. Correlation R = 0.572 (P=3.57). Slope= 0.084 (P=3.57). Intercept= -3.36 (P= -5.46).

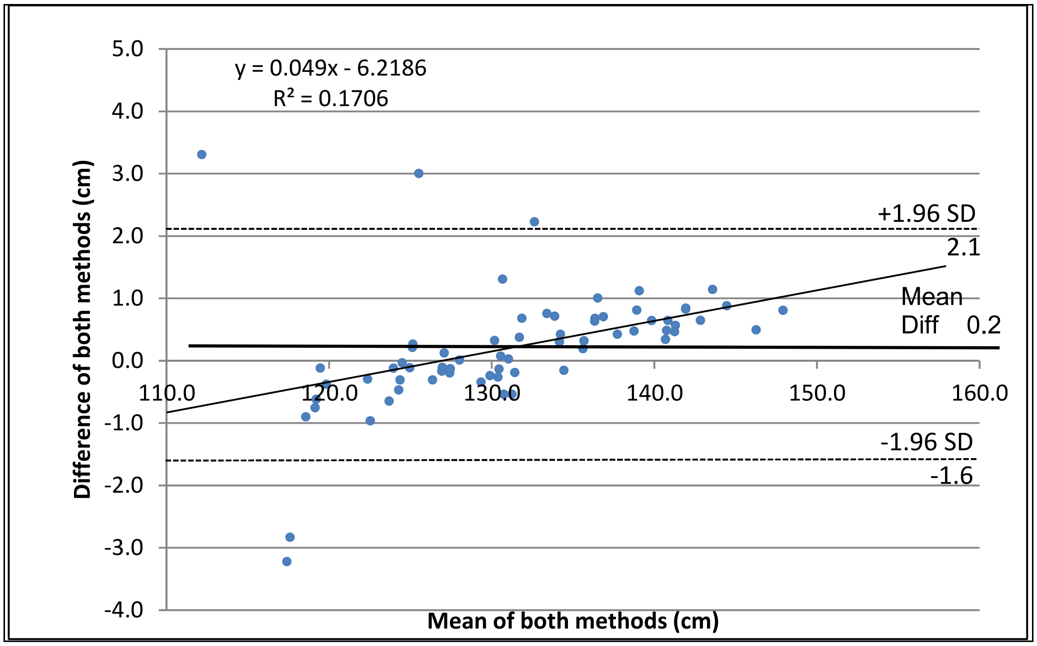

Figure 2. Bland and Altman plot of the Y co-ordinates data obtained from 68 paired samples generated from the Motion Analysis Cameras and Optojump™. Correlation R = 0.413 (P<0.01). Slope = 0.49 (P<0.01). Intercept = -6.22 (P<0.01).

DISCUSSION: Results show correlation coefficient values of 0.572 for the x coordinates (Figure 1) and 0.413 for the y coordinates (Figure 2) which by Hopkins (2002) indicates large (x coordinates) and moderate relationships (y coordinates). Along with this the R^2 results indicate that 33% of the variance in the MAC x coordinates can be explained by variation in Optojump™ and 17% of the variance in the MAC y coordinates can be explained by variation in the Optojump™. This shows that the variance in both systems is shared thereby reducing the error. The 95% limits of agreement also indicate that out of 68 trials only 2 trials lay outside this range for the x coordinates and 5 for the y coordinates. This indicates that there was limited systematic bias during the trials and these outliers could be due to the variation seen. The limits of agreement also have a range of 3.3 cm for the x coordinates and 3.7 for the y coordinates indicating narrow limits of agreements and indicating good inter-method agreement. This indicates that the Optojump™ is a valid and relatively low cost method for biomechanists to measure performance without access to 3D motion analysis or field-based analysis. The large and moderate relationships indicate good validity against the gold standard whilst the shared variance and limited systematic bias indicate that neither system has increased error over the other.

CONCLUSION: The Optojump™ protocol is a valid measure for calculating performance measures as compared to the gold standard MAC. It has practical applicability to an amateur population as the largest differences between the coordinates systems were between 3.3 and 3.7 cm, roughly half the width of a tennis ball, and so would be of little concern. However this difference could mean whether a ball fell in court or off the court and so perhaps has is not as well suited to professional athletes. Future research should be done in this area to see where the variability within the coordinates comes from and to investigate the application of this protocol to various sports.

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