THE ASSOCIATION BETWEEN UNILATERAL BALANCE AND KICKING

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Balance is a common coaching cue and technical factor associated with kicking in the football codes. The aim of this study was to compare balance ability and maximal kick performance for the punt kick. Fifteen elite junior Australian Football players performed maximal punt kicks with their preferred and non-preferred legs with foot and ball speed calculated using VICON. Balance ability was assessed unilaterally during three 20 s standing tasks on a force plate using centre of pressure range and medio-lateral force standard deviation. No relationship was found between balance ability and kick performance, similar to soccer kicking. Future work should explore balance in more kick-specific tasks.

KEY WORDS: Force plate, performance, stability, Australian Football.

INTRODUCTION: Balance is the ability to control body position relative to the base of support (McLester and St Pierre, 2008) and is considered to be a fundamental constraint on how skilled movement is organised (Chew-Bullock et al., 2012; Gibson and Pick, 2000). This balance ability is considered to be important to many sports skills in terms of performance and injury prevention (Hrysomallis, 2011). Static balance is crucial in sports such as rifle shooting where very small amounts of body sway can affect performance (e.g. Ball et al., 2003). Dynamic balance has also been linked to performance although this relationship has been less developed within the literature (Chew-Bullock et al., 2012).

Balance is a common coaching cue and technical factor associated with kicking in the football codes and has some scientific support. Chew-Bullock et al. (2012) examined 38 soccer kickers with a range of skill levels performing place kicks for maximum speed and for accuracy. The authors found that kicking performance correlated with balance ability, defined by stability during a 30 s single legged stance task for accuracy conditions ($r = 0.4$ to 0.59 for the different measures used). More specifically, better balance on the support leg was associated with greater kicking accuracy when kicking with the preferred leg.

While balance and kicking have been examined for soccer, this has not been performed in the punt kick. Ball (2011) reported technical differences between the soccer kick and punt kick and warrant the kicks being examined separately. Further, with the approach of the punt kick being more parallel to the line of the kick, medio-lateral balance would seem to be extremely important as deviations in the balance might directly relate to an altered foot position at ball contact and in turn an off centre impact. The aim of this study was to correlate balance ability with kicking performance in the punt kick in elite junior Australian Footballers.

METHODS: Fifteen elite junior Australian Football kickers performed maximal punt kicks with their preferred and non-preferred leg. A ten camera VICON system (VICON Nexus, Oxford Metrics, Oxford, UK, 500 Hz) tracked markers on the head of the fifth metatarsal as well as four markers on the ovoid ball and data was transferred to Visual 3D. To obtain foot speed at the instant before ball contact, XYZ coordinates of the marker on the head of the fifth metatarsal was truncated at the instant before ball contact, padded by reflecting and inverting the previous 20 data points, smoothed using a 15 Hz Butterworth digital filter (decision based on spectral analysis, effect of different cut-offs on parameter values, visual inspection of

curves and use of automated methods, Coventry et al., in press), before removing the padded data and calculating the resultant 3D velocity using the three point central differences method. Ball speed was calculated as the average velocity of the geometric centre of the ball five frames immediately after the ball had left the boot. Foot to ball speed ratio was then calculated by dividing foot speed by ball speed. Prior to kicking, players performed three 20 s balance tasks which involved stepping onto a compliant polyvinyl chliride foam (density 55 $kg.m^{-3}$, height 70 mm, Airex, Switzerland) placed on an AMTI force plate (BP900 900-2K-CTT, Advanced Mechanical Technologies Inc., Massachusetts) with hands on hips and the non-supporting knee held at 90 degrees (Hrysomallis et al., 2006). Data were recorded in Bioware software (Kistler Instruments AG, Winterthur, Switzerland) and medio-lateral centre of pressure range (CP Range) and medio-lateral force standard deviation (Fy SD) were calculated. These measures have been used in previous work (e.g. Ball et al., 2003; Hrysomallis et al., 2006) and represent two different aspects of balance – one is the amplitude of sway and the other an indication of the rapidity in which the balance point moves. The mean of the three balance trials were used for each kicker in subsequent analyses. The relationship between balance measures and kick performance measures were then examined, correlating preferred leg balance data with non-preferred leg foot kick performance data and vice versa. Significance was set at 0.05 with a Holms coorrection used to adjust for the multiple statistical tests.

RESULTS:

Mean performance data and comparison statistics comparing the preferred and non-preferred leg kicks, are presented in Table 1.

Table 1
Mean kick performance and preferred/non-preferred leg comparisons

	Kick Leg	Mean	SD	t-test	Effect size	Effect Classification
Foot Speed (m/s)	Preferred	23.6	1.6			
	Non-Preferred	21.7	1.7	<0.001	1.15	Large
Ball Speed (m/s)	Preferred	26.6	2.1			
	Non-Preferred	23.8	2.1	<0.001	1.33	Large
Ratio	Preferred	1.13	0.09			
	Non-Preferred	1.10	0.09	0.19	0.19	None

Mean balance data is presented in Table 2. No significant differences existed between legs for balance ability.

Table 2
Mean Balance data and preferred/non-preferred leg comparisons

		Mean	SD
Preferred	CP Range (m)	0.05	0.01
	FySD (N)	8.60	2.34
Non-Preferred	CP Range (m)	0.05	0.01
	FySD (N)	8.20	2.72

No significant relationships existed between balance ability and foot speed, ball speed or ratio (Table 3).

Table 3
Correlations between kick performance and balance ability

		Foot Speed	Ball Speed	Ratio
Non-preferred foot kick - preferred foot balance	CP Range	0.38	0.17	-0.18
	FySD	0.01	-0.01	0.02
Preferred foot kick – non-preferred foot balance	CP Range	-0.03	-0.17	-0.14
	FySD	0.08	-0.07	-0.12

DISCUSSION: Foot and ball speeds were significantly larger for the preferred compared to non-preferred legs, similar to findings for senior players (Ball, 2011). Foot speed was approximately 2 m/s faster while ball speed was approximately 3 m/s faster for the preferred leg. Also similar to the findings for senior players, no different in foot to ball speed ratio existed, although the preferred leg was 0.03 higher. For balance ability, no difference existed between legs for either measure, similar to findings in soccer kickers (Chew-Bullock et al, 2012).

Balance was not related to maximal kick performance in the punt kick. Correlation values indicated no effects for all relationships with the exception of the non-preferred leg kicks between foot speed and CP Range, which indicated a medium non-significant effect. This result might suggest that balance ability was unimportant on a group basis for the kickers tested. The influence of the support leg, then, might be more important to the ability to transfer momentum to the ball, as found by Ball (2013) for senior kickers. It might also be simply a limitation of the balance measures used and the lack of other factors measured such as strength and limb length, although the current group tested were homogenous in terms of age and skill level, a point of difference with the Chew-Bullock study which used a wide range of skill levels.

A number of limitations need to be addressed in future studies. First, a balance task that more closely replicates the demands in kicking might provide stronger insights for any relationship between kicking performance and balance ability. While this approach was a valid first step, with standard balance measures that have been found to be reliable and used in previous sports research, these measures require refinement. Chew-Bullock et al (2012) suggested standing while swinging the kick leg forwards and back might be a better task. The authors also suggested stepping onto an unstable surface as a potentially better task, however, this was the approach taken in the current study so this avenue would seem to be less useful. Certainly comparing a task that lasts 20-30 s with one that lasts less than a second requires refinement of measurement methods, acknowledging the obvious difficulties of finding a reliable measure for the combination of a short period and dynamic task. This direction is essential to pursue given the consistent reporting of the importance of balance. Biomechanical analyses need to develop further to provide greater understanding of this component of sport. Second, the sample size was relatively small for this study. While this would not seem likely to alter the relationships with trivial effect sizes, the medium effect between non-preferred leg balance with preferred leg kicks ($r = 0.38$) would have been significant with $N = 25$ participants so further work using the current methodology but with larger numbers has merit.

CONCLUSION: Balance, as measured by a 20 s single legged standing task, was unrelated to kick performance.

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