ORIGINAL INVESTIGATION
The Effects of Kicking Leg Preference on Balance Ability in Elite Soccer Players
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Abstract

Soccer has a high number of lower limb non-contact injuries, with leg asymmetry linked to this injury occurrence. Screening for balance deficits is used as a predictor of potential injury; therefore the aim of this study was to determine whether static and dynamic balance differs in elite soccer players preferred kicking and non-preferred kicking legs. Fifteen male professional soccer players were tested for static balance; standing on one leg, and dynamic balance, a hop and hold task and a kicking task. Balance ability was assessed by measuring centre of pressure deviation. Results indicated that static balance and hop and hold tests were not significantly different ($p>0.05$) when dominant and non-dominant kicking legs were compared. The kicking balance task indicated a significant increase ($p\leq0.05$) in balance ability for the player’s non-dominant limbs. Further, left sided players had significantly better ($p\leq0.05$) dominant leg balance when compared to right sided players. These findings suggest that the static and dynamic balance tasks employed in this study were not specific enough to establish possible balance asymmetries in professional elite soccer players, while the passing dynamic balance test seems to be sensitive enough to show dominant and non-dominant leg discrepancies. It is therefore suggested that balance tasks, used to screen players, need to mimic the actions linked to injuries within soccer in order to explore dominant and non-dominant asymmetry.

Key Words: balance, asymmetry, injury, leg dominance
Introduction

Soccer is a sport which seems to inherently have a higher injury incident rate than most field invasion games; most commonly exemplified by lower limb muscle strains and ankle and knee sprains [1]. A number of deficiencies and imbalance factors have been correlated to soccer injuries within both elite and sub-elite groups; these have included poor trunk/postural stability [2] reduced knee joint position sense [3] and poor ankle proprioception [4].

Of particular importance is the high prevalence of injuries to the anterior cruciate ligament (ACL) within soccer, these can be career threatening in professional soccer, therefore methods of prevention are of great interest to players and coaches alike [5]. Asymmetry between the preferred kicking and non-preferred kicking leg in players has been identified in terms of muscle thickness, strength and activation discrepancies [6-9]. The bilateral differences between the limbs are believed to contribute to ACL injury; therefore detection of asymmetry would appear to be important [10]. Interestingly, Brophy [11] demonstrates that male players are more prone to non-contact ACL injuries on their preferred kicking leg rather than their non-preferred kicking leg; suggesting that leg asymmetry could be an important factor in explaining ACL injury.

However, these bilateral differences are unlikely to be linked to muscle asymmetry. Cometti et al. [12] reported that hamstring to quadriceps (H:Q) ratio and extensor to flexor muscle groups force was similar when professional players dominant and non-dominate legs were compared. If gross muscle performance for elite players is similar in dominant and non-dominant limbs, could a lack of balance be more relevant in terms of explaining injury discrepancies between preferred and non-preferred kicking legs?
Matsuda et al. [13] compared sub elite soccer players to non-players static balance asymmetry and found soccer players to have better balance than non-players. However, no difference between preferred kicking and non-preferred kicking legs was shown. Interestingly, Teixeira et al. [14] reported increased reliance on the non-preferred kicking leg in mobilization and stabilization tasks. Athletes perceiving their non-dominant leg as stronger than their preferred kicking leg, however, no correlation was found between this preference and inter-lateral balance asymmetry. Gstottner et al. [1] measured static and dynamic balance in players, observing exaggerated foot dorsi-flexion, hip rotation and arm use in soccer players and poor overall performance, with a greater need for stabilization using the arms and gluteal muscles when balanced on the preferred kicking leg compared to non-preferred leg, but these differences were found to be statistically non significant.

Although static and dynamic balance have been assessed in elite soccer players in comparison with sub-elite and non-players [14] and under fatigue conditions [15], balance asymmetry has yet to be tested in the elite population. This sub-group seems to have improved balance compared to sub-elite soccer players, probably due to the neuromuscular adaptations, such as increased maximum neural activation and muscle fibre area [16] brought about by increases in strength and sensor motor training [17] in elite athletes. These increased physical capacities should help prevent lower limb injuries, but elite players still seem to be prone to injury, maybe leg balance asymmetry within elite players could help explain the high prevalence of non-contact injuries observed [1].

This study aims to determine whether static and dynamic balance differs in elite soccer players preferred kicking and non-preferred kicking legs. It is hypothesised that there will be a
significant decrease in static and dynamic balance for the preferred versus the non-preferred kicking leg.

**Methodology**

**Participants**

Participants (males, \( n = 15 \) (right footed \( n = 11 \), left footed \( n = 4 \)), age = \( 24 ± 7 \), height = 183.86cm ± 5.16, mass = 79.9kg ± 9.13) were selected using a targeted convenience sample from an English League One soccer team. Participants undertook a repeated measures, randomised, counterbalanced designed trial at the beginning of their pre-season. Procedures were approved by a Departmental Committee for Ethics. Participants completed a health screen and were provided with written and oral information regarding the experimental protocol and possible risks of participation, before written signed consent was obtained. All players reported no present lower limb injuries which could affect the balance tasks they were asked to attempt. Participants were asked not to consume alcohol or perform any physical activity in the 24 hours prior to the test session. Participants were required not to consume food or any caffeine products for 4 hours prior to testing.

**Experimental Procedure**

All balance tests were conducted using an RSscan balance testing pressure plate and associated footscan balance 7.7 softwear (RSscan ltd, Ipswich, United Kingdom), calibrated to a known mass before each test session. Balance was assessed by measuring the deviation of centre of pressure (CoP) within a posturogram at a 100 Hz sampling frequency. This involved recording the mean CoP during the assigned balance task and establishing the standard deviation of the anterior posterior and medial lateral movement (mean amplitude in millimetres) from this CoP.
This produced a resultant distance peak pressure travelled from the mean CoP during the assigned balance tasks [1, 13, 15, 18-19], with a lower SD indicative of superior balance ability. Prior to testing, subjects were asked to identify their preferred kicking leg. All trials were completed barefoot to eliminate any aid to balance provided by athletic footwear [20]. Influencing factors such as fatigue and tiredness from training were controlled by conducting testing after subjects rest day from training.

Reliability and Familiarisation Process

Reliability was calculated by a Coefficient of Variation (CoV). Pilot work to establish task reliability was performed on 10 collegiate soccer players. They reproduced the 3 balance tasks 10 times producing a CoV for the static balance task of 19%, hop and hold task (CoV=9%) and kicking task (CoV=12.8%). When the first 4 and last 3 repetitions of each measure were discarded the CoV was substantially reduced (static balance task 4.6%, hop and hold task 7.2%, kicking task 5.7%). Therefore, based on this pilot work the experimental group were required to perform 4 practice efforts of each balance task, to familiarise themselves with the required protocol, before performing 3 repetitions of each task. This produced a reliability for the static balance task (CoV=3.3%), hop and hold task (CoV=6.2%), kicking task (CoV=4.3%).

Assessment of Static Balance

In the static balance tests, subjects were asked to stand on the RSscan plate with their head upright facing straight ahead [21], with the visual system not looking at their stance foot. The non- balance leg held at 90° hip flexion and the hands held by subject’s sides. Participants underwent a ten second test, standing on their non-preferred kicking leg (NKL) and on their preferred kicking leg (KL).
Assessment of Dynamic Balance

In the dynamic balance tests, subjects underwent a one metre hop and hold test. Participants hopped onto the plate from a marker on the floor, and were required to hold their landing for at least three seconds. Holds of less than three seconds were disregarded and the trial repeated, in accordance with Myer et al. [22] protocol. Participants performed a hop and hold test with their non-preferred kicking leg (HHNK) and preferred kicking leg (HHK). CoP deviation from landing to one second was used to represent dynamic balance on landing.

A second dynamic test was performed, were subjects underwent a trial in which they replicated a passing action to establish match specific balance. This consisted of players planting their standing foot on the RScan plate, while swinging their other leg in an open kinetic chain pattern making contact with a ball in an instep passing action. This was performed for both the non-preferred kicking (PASSNK) and preferred kicking (PASSK) legs, with CoP from foot placement to one second used as the measure of balance. In the dynamic tests eye position was standardised, with the hop and hold test reproducing a head up position, were ‘spotting’ the contact foot was discouraged. In the passing test players were asked to look at the stationary ball which was positioned on the same spot for each subject, and not to concentrate on the stance limb, while the kicking action was performed.

Statistical Analysis

All data was considered to be normally distributed as the Shapiro-Wilk’s (<50 subjects) test for normality was found to have an alpha level of $p>0.05$. A 2x2x3 factorial repeated measures ANOVA was conducted to assess the difference between left and right sided players, the
difference between preferred and non-preferred kicking leg and any differences between the 3
balance tasks. Pairwise post-hoc comparisons were performed with a Bonferroni adjustment.
Statistical testing was carried out using SPSS statistics version 17 (SPSS Inc, Chicago, IL, USA)
with an alpha level of $p \leq 0.05$. 
Results

Fig. 1 about here

Effect of Kicking Leg Preference in Balance Tasks

Figure 1 presents data exploring kicking leg preference within the 3 balance tests. The hop and hold and the static tests of balance were not significantly different ($p>0.05$) when legs were compared, however the pass balance test had a different response. The preferred kicking leg was shown to have significantly worse ($p=0.05$) dynamic balance, calculated as a 25% balance discrepancy compared to the non-preferred kicking leg.

Table 1 about here

Comparison of Left and Right Footed Players

Table 1 compares the response of left and right footed players when their preferred and non preferred kicking legs are compared. The static and the pass balance tests found left and right sided players had no significant differences ($p>0.05$) when preferred or non preferred kicking legs were compared, the hop and hold balance test had a different response. The non-preferred kicking leg was shown to have no significant difference ($p>0.05$) comparing right and left sided players, but the preferred kicking leg was shown to be significantly worse ($p=0.021$) for right footed players, calculated as a 35.7% balance discrepancy, compared to left footed players.

Discussion

The present study found no significant difference between the preferred and non-preferred kicking legs in terms of the static or hop and hold balance tasks. However, the passing balance test showed that players preferred kicking limb was significantly worse in terms of dynamic...
balance compared to the non-preferred leg. This may suggest that the static and hop and hold
dynamic balance tasks employed in this study were not specific enough to establish possible
balance asymmetries in professional elite soccer players. While the passing dynamic balance test
seems to be sensitive enough to show kicking leg discrepancies.

Soccer has a high incident of non-contact injuries [1], which have been linked, in part, to player
asymmetries in balance/proproprioception [2-4, 15]. The findings from this present study may be
important in terms of attempts to screen players for potential non-contact injury.

Soccer is a game were players are usually in motion [23], with faster more dynamic actions
inherently holding more potential to injure players. Quick cutting actions, required for
directional changes at speed, are commonly required in match play [24], with more than 50 turns
performed per match [25] putting athletes at increased injury risk (particularly in terms of knee
injuries). The stance leg, in these actions, has to cope with high levels of torque and shear force,
increasing the risk of injury compared to linear movement. This problem is exasperated as foot
placement position tends to be sensed as more medial than it actually is [26], putting a greater
stress on the knee. Therefore, if the stance leg has limited ability to land and stabilise during
ground contact a greater propensity for injury is inherent. It seems that position sense and
balance are vital to limit this potential injury occurrence.

Screening for poor balance or balance asymmetry is seen as a way to predict injury potential, as
long as the test involves muscle synergy, specific to the movements which are likely to cause
injury [27]. Therefore, the type of test to assess player balance is vital. Static balance tests, such
as the stork test employed as a static measure of balance in this present study, are often
performed as part of the screening process. Our results would suggest that this type of test is not
sensitive enough to detect meaningful imbalances. In soccer systems are very rarely required to maintain balance for lengthy periods. During stance balance is required for no longer than a stretch shortening cycle action, usually less than 0.3 s [28]. Therefore, more dynamic assessments of balance are more specific to the actions performed in soccer and more likely to explore meaningful balance deficits.

The findings from this study indicate that players had no static balance asymmetry between their preferred and non-preferred kicking legs, while the dynamic hop and hold balance tests found minimal asymmetry (3.3%). However, the test most specific (passing), to actions within soccer, produced a large symmetrical discrepancy (25%), with the preferred leg significantly inferior in its balance ability compared to the non-preferred leg. The difference between dominant and non-dominant legs could be linked to a strength deficit frequently associated with soccer players. Zakas [29] found that dominant legs were weaker than non-dominant legs, thought to be due to the non-dominant leg being planted while the dominant leg is used to swing and kick. This is important as increased strength is linked to prevention of musculo-skeletal injuries and better balance ability [30]. Another potential reason for balance discrepancies is linked to the amount of attention players input into the balance tasks. Underlying control process are largely autonomous, with little cognitive burden or attentional demand. This allows concurrent actions, usually involving more attention-demanding tasks, to be accomplished [31]. Therefore, players can make complex cognitive decisions, while their balance system is controlled automatically. However, past research does indicate that the more complex the balance task the greater the attentional demand, leading to an increase in CoP fluctuation [32]. This means if players are used to balancing on their non-dominant leg while kicking, than they may be able to maintain better dynamic balance as less attentional focus will be required to maintain a stable base,
allowing a more autonomous and therefore efficient process. Therefore, any decrease in balance ability within player’s dominant legs could be linked to an increase in injury potential. Interestingly, the proprioceptive system consists of kinaesthetic, proprioceptive, tactile, visual and vestibular inputs [33], with visual input vital in maximising balance ability [19, 34]. However, in soccer, players do not look at where they place their feet while moving around the field of play. They tend to scan the playing area, causing motion of the eyes, impeding the proprioceptive system, causing a reliance on the vestibular inputs in terms of governing balance and movement [35]. This means that both testing and training of the balance system needs to be conducted without the use of direct visual feedback [33], to mimic the sporting activities requirements. In the present study the head position was standardised in the balance tests, to try to mimic the visual input players would receive in a game situation. Therefore, the static and hop and hold tests had limited visual input (looking straight ahead), while the pass test, had more visual input due to players focusing on a point where they would kick a ball (parallel to their stance foot).

Left and right footed players preferred and non-preferred kicking legs were compared, with left footed players dynamic (hop and hold) balance found to be significantly better than right sided player’s when comparing dominant legs. This difference may be because left sided players tend to be more able with their non-dominant side than right sided players. They tend to have to use both sides of their body to a greater extent than the right sided population, during everyday tasks. This may lead to residually greater function in their non-dominant side, leading to greater confidence to kick with their non-dominant side. Therefore, left sided players may use their dominant limb to stabilise more frequently, during matches and training, as they are less reliant on kicking with their dominant leg and therefore achieve better dominant leg balance scores as
they will need to focus less attention on this limb. Interestingly, this could cause left sided
players to have greater attentional focus available to make decisions during play, leading to
better decision making when kicking with their non-preferred leg compared to right sided
players. Whether differences in decision making are apparent for left and right sided players is
as yet unknown, but may be an interesting area of study in the future.

This study’s findings would indicate that balance discrepancies between kicking and non-kicking
legs do exist in elite soccer players, but that these asymmetries are only apparent when specific
balance tasks are used. It is therefore suggested that balance tasks, used to screen players, need
to mimic the actions specific to soccer in order to explore dominant and non-dominant leg
asymmetry.

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Figure 1: Mean and SD of CoP deviation between preferred kicking non-preferred kicking legs (n=15).

* Denotes significant differences between non dominant kicking and dominant kicking legs (p≤0.05).
Table 1: Mean and SD± CoP deviation comparing left and right footed players in different balance tasks.

<table>
<thead>
<tr>
<th>Group</th>
<th>Static Balance (mm)</th>
<th>Dynamic Balance (mm)</th>
<th>Pass Balance (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Footed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-dominant</td>
<td>200 ±74</td>
<td>215 ±62</td>
<td>109 ±79</td>
</tr>
<tr>
<td>Dominant</td>
<td>191 ±58</td>
<td>238 ±105*</td>
<td>144 ±83</td>
</tr>
<tr>
<td>Left Footed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-dominant</td>
<td>204 ±54</td>
<td>185 ±50</td>
<td>125 ±53</td>
</tr>
<tr>
<td>Dominant</td>
<td>192 ±72</td>
<td>153 ±54*</td>
<td>178 ±67</td>
</tr>
</tbody>
</table>

* Denotes significant differences between dominant dynamic balance tasks for right and left footed players (p ≤ 0.05).