# The effect of acute match play loading on hip adductor strength & flexibility in soccer players. Author: **N. Light**

# Abstract:

# Background: Deficits in adductor strength and flexibility are known risk factors for soccer hip/groin injury, yet little is known about the acute effects of soccer match play on these physical features. The aim of this study therefore was to examine the changes in adductor strength and flexibility before; during and immediately after soccer match play. Methods: Design: Twenty, male university soccer players (age = 22.35 ± 1.98 years) participated in this field-based, within subject, repeated measures study. Each participant performed three adductor squeeze tests at both 0° and 45° hip flexed test positions alongside a bent knee fall out test. Adductor squeeze scores were quantified using pressure sphygmomanometer and BKFO values recorded in centimetres. Each test was performed before (0 mins) half time (45 mins) and at full time (90 mins) of a competitive match. Results: Adductor strength decreased by 17.7% in 0° test position and 19.1% in 45° test position at 90 minutes of soccer play, whilst BKFO scores increased by 15% indicating a reduction in adductor flexibility. Statistical analysis showed significant effects of time Vs adductor strength and squeeze test position (P=<0.005), Positive correlations between time played and BKFO scores, and BKFO scores vs adductor squeeze scores at 0 and 45 minutes (P=<0.005) were also observed. Conclusion: University soccer players exhibit decreased adductor squeeze test and BKFO values as soccer match duration increases. These findings may have implications hip/groin injury management and recovery strategies, post or during soccer matches.

# Introduction

Hip and groin injuries in athletes represent a considerable clinical challenge for sports medicine staff; with time-loss from playing,1 high rates of recurrence2 and decreased level of sporting function upon return to play.3 All characteristic features of such injury. In particular, soccer players of all standards can further experience high levels of symptoms whilst they continue to compete.4 The prevalence of these injuries is closely correlated to the nature of the sport played with cutting, changing direction and kicking are characteristic features of association soccer that result in high levels of stress transferred across the hip / groin region.5

Subsequently, soccer players groin musculature must be capable of withstanding the significant loads required of them during soccer activity. It is not surprising therefore that reduced adductor muscle strength and hip range of motion / flexibility are regarded as key risk factor for associated injury.6 Indeed, low pre-season adductor strength may even have prognostic value in developing future groin pain.7

Despite increasing our understanding of risk factors associated with hip/groin injury in recent years;8 it should be acknowledged that merely screening these physical components on an arbitrary, pre-season basis is unlikely to offer injury-predictive value.10 A more suitable strategy than relying on arbitrary scores, would be to assess relevant outcome measures frequently and identify if any fluctuations that may be of clinical importance.11 For example, regular efficient monitoring of adductor strength can allow clinicians to identify and investigate episodes of reduced strength,11 which has been found to significantly decreased both in the weeks preceding groin injury.12

The effects of repeated match loading on injury has been somewhat narrowly explored to date; although it appears that increased fixture congestion may be associated with increased muscle injury occurrences,13 whilst unbalanced training loads may render the player physically un-prepared and susceptible to injury.14 However, there is very limited published evidence examining acute match play loading itself. In an isolated example, the effects of match loading on groin related clinical measures were explored, identifying a possible threshold effect, whereby match play negatively influenced hip flexibility,10 holding potentially important clinical implications. However, a better understanding of adductor strength and flexibility responses to acute match play loading may assist clinicians and coaches with planning more suitable training schedules and to incorporate optimal recovery strategies.

Therefore, the aim of the present study was to identify the effects of match play loading on key hip/groin related clinical measures; the adductor squeeze and BKFO tests, by recording measures pre, during and immediately post soccer activity. It was hypothesised that the performance of the above measures would be demonstrate a negative exponential relationship with duration of match play.

Method

Design
A within subject repeated measures design was used in which comparisons were made between hip adductor muscle strength and flexibility over the period of a 90-minute soccer match.

Participants
Twenty male university level soccer players from four different clubs (age = 22.35 ± 1.98 years, height = 177.65 ± 5.58cm, body mass = 79 ± 7.45kg) were invited to participate. All participants were University team soccer players playing in the British Universities & Colleges Sport (BUCS) league. These recreational, yet competitive players trained twice per week (60 min) and played competitive matches weekly. Players who reported any hip/groin pain within 1 year prior to the study were excluded from the study. Participants provided signed informed written consent and ethical approval for the study was granted by the University of Chichester (UK) ethics committee.

Procedures
For adductor squeeze testing; the participants were placed in a crook lying position without a pillow and with arms across their chest to prevent additional force being achieved.15 The participants were tested in two hip positions (0° and 45°) which were confirmed with a universal goniometer.16 The testing was quantified using a sphygmomanometer (Welch Allyn Disytest, Skaneateles, New York, USA); pre-inflated to 10mmHg.16 The pre-inflated cuff was then placed between the most prominent aspects of the medial femoral condyles (between knees). Each participant was given two sub-maximal trials to familiarize them with the testing protocol.6 The participant then completed three maximal voluntary contraction (MVC) test with the mean measure calculated and recorded. The examiner used a set standardized command of “go ahead-push-push-push relax”.17 The participants were naive to their own previous and counterparts scores to avoid any competition affecting results. To perform the bent knee fall out (BKFO) test the player was positioned in a crook lying position with their knees flexed to 90° (confirmed with a universal goniometer) and their feet together. The participants were instructed to allow their knees to fall outward whilst the examiner used gentle over-pressure to check that the player had relaxed at the end range of movement. The distance between the proximal head of the fibula and the surface of the ground was measured using an inflexible tape measure (to the nearest 0.5 cm) and recorded. The BKFO test was conducted as a single measure with a value recorded for both right and left limbs.

Both tests were collected at three stages during a competitive soccer match performed on a grass pitch; five- minutes prior to kick off (post non-specific cardiovascular warm-up); during the half time interval (between 45 & 60 minutes); and at full time (90 minutes) of the match. All testing followed standardized testing protocol described in previous literature.16 All players were tested in February 2016, midway through the league season and all tests were completed by a single examiner (T.O).

Data Analysis

The hip adductor strength and flexibility data was inputted into Microsoft Excel (Microsoft Corporation, 2013) and further analyzed using SPSS software (version 23, IBM). The adductor squeeze data (mmHg) were normally distributed and a two-way repeated measures ANOVA test was conducted to determine whether there was statistical significance between hip adductor strength values over hip flexion angle (0° and 45°) and time. The BKFO data (cm) were not normally distributed and a Freidman test with Wilcoxon post hoc tests were applied. A Pearson’s correlations between the squeeze and BKFO data was also conducted. A level of p<0.05 was used to indicate statistical significance.

# Results

Mean ± SD & 95% confidence interval data for adductor squeeze testing over hip flexion angle and time groups are shown in table 1. (Table one near here)

The 0° squeeze position had a mean reduction of 22.25 (-10.3%) mmgh between 0 and 45 minutes and a further reduction of 15.917 (-8.25%) mmgh between 45 and 90 minutes, representing a total reduction of 38.16 mmgh (-17.7%) from the start (0) to the end (90) of the match. The 45° squeeze position had a mean reduction of 26.25mmgh (-11.3%) between 0 and 45 minutes and a further reduction of 18.08mmgh (-8.8%), representing a total reduction of 44.3mmgh (19.1%) from the start (0) to the end (90) of the match. These reductions are illustrated in figure 1. (Figure one near here)

A Two-way Repeated Measures ANOVA demonstrated a significant effect of time influence on squeeze test scores, *F*2,38=106.544, *p* <0.05. There was also a significant effect of angle of hip flexion on squeeze scores *F*1,19= F2,38=106.544, p <0.05 and for Time\*Angle during squeeze testing, F2,38=3.248, p <0.05.

Figure 2 shows the change of scores for the BKFO test at 0, 45 and 90 minutes. The mean (cm) BKFO scores were 23.8 ± 2.4 at 0 minutes; 26.7 ± 3.5 at 45 minutes and 27.9 ± 3.5 at 90 minutes. Therefore, there was an 11% (+2.9cm) increase in scores between 0 and 45 minutes; a 4% (+1.2cm) increase between 45 and 90 minutes and a total increase of 15% (+4.1cm) from the start (0) to the end (90) of the match. (Figure 2 near here)

The results of the Friedman test indicated that there were significant differences between the three time groups in the right and left BKFO values; Right = χ22 = 24.603, p = 0.001; Left = χ22 = 22.464, p = 0.001.

Results of the of the Wilcoxon post-hoc test revealed statistically significant low to moderate decreases for all BKFO scores in relation to time; 0 min to 45 min = *z* -3.19 – 3.45 *p*= 0.001; 45 min to 90 min = *z* -2.70 – 2.85 *p* = 0.007 and 0 to 90 min = *z* -3.48 – 3.63 *p* = 0.001.

A Pearson’s correlation found a statistically significant association between for 45° squeeze test at 0 mins for left and right BKFO; *rp* = 0.443, *p* = 0.050; BKFO and *rp* = 0.447, *p* = 0.048 respectively. The 45° squeeze test was also associated at 45 mins for left and right BKFO; *rp* = -0.481, *p* = 0.032 and *rp* = -0.500, *p* = 0.025 respectively. No other statistically significant associations were found including the 45° squeeze test at 90 minutes nor any of the 0° squeeze tests.

# Discussion

The main findings of this study were 1) soccer match-play load reduced mean hip adductor muscle strength by 17.7% in 0° test position and 19.1% in 45° test position and 2) soccer match-play load decreased mean hip adductor muscle flexibility by 16.9% over the course of the 90-minute soccer match.

The results of the current study are comparable to previous findings10 whereby hip adduction strength via a squeeze test was decreased by 12.5% post 90-minute soccer match. The authors also reported that the hip adductor muscle flexibility via a BKFO was decreased by 20.7%. In the present study, the adductor muscle strength data for both the squeeze test positions utilised was marginally higher than previous findings;10 which may be explained by differences in data collection environment (pitch-side floor based testing) and the use of a pressure sphygmomanometer as opposed to a hand-held muscle testing device. To the authors knowledge there is no published literature that compares the sensitivity between the two testing methods.

The post-match deficits in strength we observed are also similar to a previous study;18 which reported similar findings post rugby union match and importantly further reporting this decreased state may continue for up to 24 hours’ post-match. This may have significant implications for returning to activity and on-going monitoring of adductor squeeze tests within this time frame. Furthermore, our findings demonstrate that observable adductor strength deficits can be detected at 45 minutes of football activity. A mean difference in squeeze scores to differentiate athletes with / without groin pain has previously been equated to 49mmHg.6 The average difference between the baseline adductor squeeze value and the 90-minute adductor squeeze value in the present study were 38mmHg for 0° test and 44 mmHg for the 45° test. However, none of the participants here reported any pain and as such any variation in adductor squeeze strength can be considered simply as an acute outcome of football match play load.

Nevertheless, this may be useful information when considering the type of rest period undertaken during half-time intervals to ensure any risk of injury upon returning to the pitch post half-time is reduced. There is no research to knowledge that confirms a player is vulnerable to injury during this period, however with deficits in strength linked to adductor injury; more investigation into this acute reduction may be warranted.

In line with previous research,19 our findings showed that the greatest pressure values (mmgh) were observed during the 45° hip flexion position at all three stages throughout the match. This may be attributed to this testing position eliciting high levels of adductor muscle EMG activity;19 arguably placing the musculature in a mechanically advantageous position to omit force. However, when analysing relative force output to body-weight and lever length, Light and Thorborg (2016)11 found contrasting evidence where a 0° (long lever) test position achieved 69% greater mean torque values than that of the 45° position. An important difference in testing procedures however was that they11 used a HHD with the participant’s legs abducted to the length of the testers forearm. This may allow for a higher torque production due to a muscle length / moment arm optimisation;20 but it should be noted that this test position has not been validated use of a pressure sphygmomanometer and HHD incurs a significant financial cost that may be unobtainable in many soccer environments.

The BKFO data revealed an average change of 2.9 cm after 45 minutes and 4.0 cm after 90 minutes of soccer match play in both legs which is below the meaningful deficit threshold that is previously described (4.8cm).10 A relatively little amount of research has been done in the way of BKFO/hip muscle flexibility in association with injury risk and a better understanding of this so-called threshold in which match play load has a negative effect on strength and/or flexibility measures may have significant clinical implications. The BKFO test has been found to be a key measure enabling differentiation of groin pain in athletes6 yet it is unclear in which mechanical or physiological regard these affects occur. With its multi-planar /axis movement of the hip; the test is not a direct measure of hip range of motion and due to the rotatory component of the hip; unlikely to be a measure of muscle flexibility. It may be an indicator of neuro-muscular tone; demonstrating the muscles’ willingness to be elongated. Nevertheless we should seek to establish what this test is actually quantifying and how this data can be useful in injury prevention / management.

Interestingly, significant correlations were found between the 45° squeeze test and BKFO test at 0 minutes and 45 minutes no associations were found for testing at 90 minutes or using the 0° test position. This can be rationalized when considering the BKFO test is also performed in a 45° bent knee position. However, when interpreting the value of *r* it can be seen that these correlations were of low-moderate value throughout, whilst for the 45 minute variables there was a moderate negative correlation, therefore caution should be observed when considering the relevance of these relationships.

A number of study limitations must be acknowledged. Firstly, all testing was performed pitch-side due to the nature of the research which often resulted in the participant being tested whilst laying on an uneven grass field as appose to a clinical environment. However, the advantage of performing such tests pitch-side allowed for a near immediate testing procedure post-activity. Furthermore, due to the nature of the timing of tests (during a competitive match) time was limited and may have caused the players to rush. A notable limitation of the present study was the absence of any training recording / response measures (e.g. global positioning system or rate of perceived exertion), which would offer a stronger insight into the relationship between individual work output and the squeeze / BKFO tests. It has previously been found that kicking, change of direction and stretching situations, are common mechanisms for acute adductor injury21 and we suggest that future studies report data on player movements, which may provide a link between player movements/actions and subsequent performance of clinical measures. Finally, we acknowledge a lack of power analysis in estimating an appropriate sample size and believe this would have indicated the need for more participants, which in turn may have resulted in higher correlation values and confirmation of findings through repeated match analyses.

# Conclusion

The findings from this study demonstrate that soccer match play load has a negative acute effect on hip adductor muscle strength and flexibility measures. Whilst the clinical relevance of these findings remains uncertain in relation to injury risk; it may provide useful information into recovery strategies during and between soccer match play.

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 **Figure legends:**

Figure 1. Line graph of Adductor squeeze mean pressure (mmHg) values for both test positions, at 0, 45 and 90 minute tests.

Figure 2.Line graph of bent knee fall out (BKFO) values (cm) at 0, 45 and 90 minute tests.