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A Four-season Prospective Study of Muscle Strain  
Reoccurrences in A Professional Football Club  

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Running head: Muscle strains in elite football
Abstract

The aim of this investigation was to characterise muscle strain re-injuries and examine their impact on playing resources in a professional football club. Muscle strains and reoccurrences were prospectively diagnosed over four seasons in first-team players (n=46). Re-injury was defined as an injury of the same type and at the same site as an index injury and which occurred after a player’s return to full participation from the index injury. Altogether, 188 muscle strains were diagnosed with 44 (23.4%) of these classed as re-injuries leading to an incidence of 1.32 strain reoccurrences per 1000 hours exposure (95% Confidence Interval, 0.93-1.71). The incidence of recurrent strains was higher in match-play compared to training (4.51, 95% Confidence Interval, 2.30-6.72 vs 0.94, 95% Confidence Interval 0.59-1.29). Altogether, 50.0% of players sustained at least 1 reoccurrence of a muscle strain leading to approximately 3 days lost and 0.4 matches missed per player per season. The incidence of recurrent strains was highest in centre-forwards (2.15, 95% Confidence Interval, 1.06-3.24), peaked in May (3.78, 95% Confidence Interval, 0.47-7.09) and mostly affected the hamstrings (38.6% of all reoccurrences). Mean layoff for non-reoccurrences and recurrences was similar: ~7.5 days. These results provide greater insight into the extent of the problem of recurrent muscle strains in professional football.

Keywords: Football; Re-injury; Injury, Epidemiology, Absence
Introduction

Contemporary professional football is known to be associated with relatively high injury rates when compared to other team sports. Research across professional European football has shown that approximately 12% of the playing season is lost due to injury (Ekstrand, Hägglund and Waldén 2009) and that injury is the main factor affecting player availability (Orhant, Carling and Cox 2010, Parry and Drust 2006). Another major concern identified across epidemiological studies in elite football is the high risk of injury reoccurrence just after return to play. Re-injury rates from 12% (Ekstrand, Hägglund and Waldén 2009) to 30% (Hägglund, Waldén and Ekstrand 2005) have been reported in professional football players when defining re-injury as an identical injury to the same location within 2 months after return to play. In addition, injury reoccurrences in professional football are generally shown to cause a substantially longer absence from play than non-reinjuries (Hawkins and Fuller, 1999; Hawkins, Hulse, Wilkinson et al. 2001; Waldén, Hägglund and Ekstrand, 2005a; Ekstrand, Hägglund and Waldén 2009) although one study has reported a similar layoff time (Waldén, Hägglund and Ekstrand, 2005b). In elite football, previous injury, return to activity prematurely, inadequate rehabilitation and incomplete recovery are potential risk factors involved in recurrent injuries (Arnason, Sigurdsson, Gudmundsson et al. 2005).

The injury types sustained in professional football players are predominantly muscle strains (Woods, Hawkins, Hulse et al. 2002; Ekstrand, Hägglund and Waldén 2009). In relation to this, re-injury rates as high as 30% have previously been reported for muscular strains (Hawkins and Fuller 1999). Indeed, muscles that are not fully restored structurally and/or functionally are likely risk factors in recurrent muscular strains (Arnason, Sigurdsson, Gudmundsson et al. 2005). Yet, there is no detailed information in the current medical literature on the impact of muscle strain reinjuries on
playing resources: proportions of the playing squad affected and unavailable to play and
working days lost or matches missed each season. Similarly, no studies have explored
the distribution of muscle strain reoccurrences across the playing season and whether
frequency and patterns vary between playing positions. Finally, studies generally report
information on ‘early’ recurrent strains that is those sustained within 2 months of a
player’s return to full participation (Hägglund, Waldén and Ekstrand 2005; Ekstrand,
Hägglund and Waldén 2009) and no data are available on later reoccurrences of muscle
strains although these injuries should be taken into account (Fuller, Ekstrand, Junge et
al. 2006). As a whole, this information would provide greater insight into the extent of
the re-injury problem in professional football whilst informing appraisal of current
injury prevention and rehabilitation regimens.

The aims of this prospective investigation of muscle strain reoccurrences in a
professional football club were two-fold: 1) to quantify the impact of muscle strain
reinjuries on playing resources; 2) to investigate the characteristics of muscle strain
reoccurrences over a 4-season period.

Methods

In this study, muscle strain injuries and re-injuries in male football players (ages
17-34 years) belonging to the first-team squad of a French League-1 Club were
investigated. While approval for the study was obtained from the present club, these
data arose as a condition of employment in which player performance was routinely
measured over the course of the competitive season and usual appropriate ethics
committee clearance was not required (Winter and Maughan, 2009). Nevertheless, to
ensure team and player confidentiality, all injury data were anonymised before analysis.

Data were collected in 46 players who participated in one or more full seasons
players who started but did not complete an entire season were not included. Altogether, 12 (26.1%), 18 (39.1%) and 16 (34.8%) players participated in one, two or three/four entire seasons respectively. Over the course of the study, the number of players in each playing position included: 5 goalkeepers, 13 defenders, 15 midfielders and 13 forwards. Players participated in up to 7 training sessions per week and 50 competitive matches per season. Individual exposure time to official competition (domestic League and Cup, and European Competition) and pre-season friendly matches was recorded for players belonging to the first-team squad. Exposure time to first-team training sessions was recorded for the squad as a whole by the team physician.

Muscle strains and reoccurrences of strains were prospectively diagnosed and documented by the team physician. Essentially, this involved routine clinical assessment of players by the physician at the time of presentation. Where necessary, further examinations were ordered (e.g., sonography or magnetic resonance imaging) at the discretion of the physician to assist with diagnosis. The team physician (certified in Sports Medicine) had over 5 years experience in this setting.

The definitions of injuries and recurrent injuries were based on those recommended by International Football Injury Consensus Groups (Hägglund, Waldén, Bahr et al. 2005; Fuller, Ekstrand, Junge et al. 2006). Injury: Time-loss injury resulting from playing football and leading to a player being unable to fully participate in future training or match play independent of whether a training session actually takes place on the day following injury or whether a player is selected to play in the next match. Specifically, strains were described as an acute distraction injury of a muscle. Recurrent injury (re-injury): An injury of the same type and at the same site as an index injury and which occurs after a player’s return to full participation from the index injury. A recurrent injury occurring within 2 months of a player’s return to full participation is referred to as an “early reoccurrence”; one occurring 2-12 months after a player’s return
to full participation as a “late recurrence”; and one occurring more than 12 months after
a player’s return to full participation as a “delayed recurrence”.

The severity of the injury (layoff time) was determined according to the number
of days the player was absent from and unable to take full part in training or
competition. All injuries were followed until the final day of rehabilitation. The player
was considered injured until the team physician allowed full participation in collective
training and availability for match selection.

All statistical analyses were conducted using SPSS for Windows Version 14.0
(SPSS Inc., Chicago, IL, USA). Standard statistical procedures were used to calculate
means and standard deviations. Injury incidence rates are presented with 95%
confidence intervals.

Results

Over the 4-year study period, players belonging to the first-team squad were
exposed to a total of 33432 hours participation time (29884 training hours and 3548
match-play hours).

A total of 188 muscle strains were diagnosed (Table1) with 44 (23.4%) of these
classed as re-injuries. The incidences of muscle strains (minus reocurrences) and
reoccurrences respectively were 4.31 (95% CI, 3.61-5.01) and 1.32 (95% CI, 0.93-1.71)
per 1000 hours play. Altogether, 74 and 114 (20.86, 95% CI, 16.11-25.61 and 3.81,
95% CI, 3.11-4.51) per 1000 hours exposure) muscle strains were sustained in match-
play and training respectively. The incidence of strain re-injuries was greater in match-
play (n=16) compared to training (n=28) respectively (4.51, CI 2.30-6.72, vs 0.94 CI,
0.59-1.29 per 1000 hours exposure). Altogether, 50.0% of players sustained at least 1
reoccurrence of a muscle strain. Players incurred a mean per season of 1.9 ± 1.0 muscle
strains and 0.4 ± 0.5 reoccurrences of these injuries. In players that completed 3 or more
seasons (N=16), there were 1.8 ± 1.0 muscle strains and 0.4 ± 0.4 reoccurrences of these injuries per player while 75% of these players sustained at least 1 reoccurrence of a muscle strain.

For the whole squad, recurrent strains accounted for a mean of 85 working days lost and 11 matches missed per season (approximately 3 days lost and 0.4 matches missed per player). Of the re-injuries, 15 (34.1%) were classed as early reoccurrences while 14 (31.8%) and 15 (34.1%) were considered to be late and delayed reoccurrences respectively. The majority (46.4%) of recurrent strains sustained in training were classed as early occurrences. Of the total number of early reoccurrences, 86.7% were incurred within 28 days of the index injury (Figure 1).

Overall, muscle strains were mostly located in the hamstring and quadriceps regions (both ~1.0 per 1000 hours exposure) (Table 1). Recurrent strains were most frequent in the hamstring (38.6% of all reoccurrences; 0.51 (CI 0.27-0.75) per 1000 hours exposure) and the groin and lower leg regions (20.5% of all reoccurrences each; 0.27 (CI 0.09-0.45) per 1000 hours exposure). Of the hamstring reinjuries, respective incidences in match-play and training of 1.41 (CI 0.17-2.65) and 0.41 (CI 0.18-0.64) were observed. The majority (80.0%) of hamstring reinjuries sustained in match-play were classed as early or late reoccurrences. Recurrent injuries made up 21.2% of all strains to the non-dominant leg and 26.6% of all strains to the dominant leg.

With respect to playing position, the incidence of muscle strain reoccurrences per 1000 hours exposure (plus total number of occurrences and percentage of the total) were: Goalkeepers = 1.10, CI, 0.02-2.18 (4, 14.3%); Defenders = 1.44, CI, 0.66-2.22 (13, 22.1%); Midfielders = 0.87, CI, 0.38-1.36 (12, 29.3%); and Forwards = 2.15, CI, 1.06-3.24 (15, 26.7%). In midfielders (58.3%) and forwards (46.7%) notably, strain re-injuries mainly concerned the hamstring region whereas the quadriceps muscles were commonly affected in defenders (38.5%).
The mean layoff time for muscle strains not leading to a reoccurrence = 7.8 ± 6.7 days, those eventually leading to a reoccurrence = 7.0 ± 5.1 days and those classed as reoccurrences = 7.5 ± 6.3 days. The mean absence time as a result of muscle strain reoccurrences classified according to the time delay with respect to the original injury was: early reoccurrences = 7.8 ± 5.9 days; late reoccurrences = 8.7 ± 6.1 days and delayed reoccurrences = 5.9 ± 6.9 days. The longest layoff time for recurrent strains was observed in the groin (9.1 ± 8.7 days) and lower leg (8.2 ± 7.4 days) regions.

The overall incidence of muscle strains (minus reoccurrences) was highest in November (5.15 per 1000 hours, CI, 2.54-7.76) (Figure 2) whereas strain re-injuries peaked in May (3.78 per 1000 hours, CI, 0.47-7.09). Strain re-injury incidence rate in training was highest in August (2.62 per 1000 hours, CI, 0.68-4.56) and May (2.69 per 1000 hours, CI, 0.06-5.45) and peaked in match-play in December (11.23 per 1000 hours, CI, 0.22-22.24). Of the early and late strain reoccurrences, the majority (21.4%) were sustained during the first two full months of the season (July and August).

Discussion

This prospective study is the first to report in-depth data on the characteristics and impact of muscle strain reoccurrences in a professional football club. Noteworthy results were that half of all players incurred at least one reoccurrence of a muscle strain and that the risk of re-injury was still strong 1-year following on from the original injury. Recurrent muscle strains were most frequent in forward players, commonly affected the hamstring region (especially in midfield and forward players) and occurred throughout the competitive season. On average, players lost ~3 days and missed 0.4 matches per season due to reoccurrences of muscle strains.

Over the 4-year season period, approximately one fifth of all muscle strains were classed as re-injuries which is more than the 9% and 17% rate observed in English
(Hawkins, Hulse, Wilkinson et al. 2001) and Swedish (Walden, Hägglund and Ekstrand 2005a) professional football but less than the 30% rate reported in other English professional football players (Hawkins and Fuller 1999). However, 50% of the present players sustained at least 1 or more reoccurrences of a muscle strain over the study period. This result suggests that despite following routine controlled functional rehabilitation programmes post-injury, including regular evaluation of muscle strength and flexibility (Peterson and Holmich 2005, Fuller and Walker 2006), the risk of incurring a reoccurrence of a previous muscle strain was still reasonably high in these professional players. In addition, over a third of all re-injuries were sustained 12-months on from the original injury. However, muscle strains were only observed over a 1-season period in a quarter of the players and therefore delayed strain reoccurrences were not accounted for in these players. Nevertheless, this finding is noteworthy and partly confirms previous speculation that injuries such as muscle strains may carry a risk of reinjury regardless of time especially if there are residual deficits (e.g., reduced strength, range of motion changes in the length-tension relationship) and structural damage (e.g., scar tissue) present several months after the initial injury (Bahr and Holme 2005; Hägglund, Waldén, Bahr et al. 2005; Hägglund, Walden and Ekstrand 2006).

In studies in professional football, the severity of re-injuries is generally shown to be significantly greater than that for the initial injury (Hawkins, Hulse, Wilkinson et al. 2001; Waldén, Hägglund and Ekstrand, 2005a; Ekstrand, Hägglund and Waldén 2009). In contrast, the mean absence time for strain reoccurrences in the present study, was similar to that reported for the original strain. This finding is in part accordance with the findings of other research in professional football which reported no difference in absence time for all types of injury and re-injuries (Waldén, Hägglund and Ekstrand, 2005b) and more specifically, that recurrent hamstring strains did not require a longer absence than the original injuries (Woods, Hawkins, Maltby et al. 2004). These results
suggest that reoccurrence of muscle strain injuries may not be as greater ‘setback’ as compared to other types of reinjury when returning to play. Nevertheless, the present muscle strain reoccurrences required an absence of >1 week and in the region of 85 working days were lost (~3 days per player) and 11 matches missed per season, highlighting the importance of avoiding strain re-injuries.

Strains to the hamstring region are the single most common type of injury at professional levels in football (Ekstrand, Hägglund and Waldén 2009) and reoccurrence of these injuries is frequent (Woods, Hawkins, Maltby et al. 2004). In the present study, hamstring strains accounted for the major part of recurrent muscle strains and notably in match-play. This may be a result of incomplete healing through inadequate rehabilitation and/or too premature return to play with these factors linked to the pressures of the contemporary game. Furthermore, the present findings showed substantially higher rates of muscular strain reoccurrences in all body regions in competition compared to training. This result is in contrast to the findings in other investigations in professional football players (Hawkins and Fuller 2001; Hägglund, Waldén and Ekstrand, 2009) which showed that the frequency of muscular strain re-injuries during training was higher than in competition. However, in these previous reports, rates of re-injury were presented as a simple percentage of the total number of strain re-injuries and therefore did not take into account the effects of exposure time as was the case in the present study. Nevertheless, both present and previous findings reflect the risk of recurring strains during the rehabilitation process when players are attempting to regain fitness especially as the major part of reoccurrences observed in training in the present players occurred within 2-months after the original injury.

Of additional note was the considerable difference in strain reinjury rates across playing positions notably in forward players and the high frequency of reoccurrences reported in the hamstring region (~50%) in these players. This latter finding is in part
agreement with research conducted in English professional football players in which forward players were also at high risk of sustaining a hamstring strain (Dadebo, White & George 2004). The authors suggested that the high instantaneous speed demands commonly observed in forward players are associated with a greater risk of incurring a hamstring strain as these injuries occur when strong concentric quadriceps contractions generate forces in sudden bursts of speed that the eccentric strength of the hamstrings cannot withstand. While there is a general need for evidence-based prevention and rehabilitation programmes for hamstrings strains (Peterson and Holmich 2005; Mason, Dickens and Vail 2007; Goldman and Jones 2010), the present results also suggest the need for programmes specifically tailored according to individual positional role.

Finally, the present study is the first to report data on the monthly distribution of muscle strain reoccurrences across the playing season. The overall incidence of strain reinjury peaked in May while rates were highest for match-play and training in December and August/May respectively. This result suggests that in elite football players, there is a risk of sustaining a reoccurrence of a muscle strain throughout the playing season. In addition, the frequency of early and late recurrences of strains was highest during the first two full months of the playing season (July and August) despite systematic pre-season evaluation of lower-limb muscle strength and flexibility. While muscle strains are common early in the competitive season in professional football players (Woods, Hawkins, Hulse et al. 2002), the present findings suggest that a non negligible part of these injuries may be reoccurrences of a previous strain carried on from the previous season or one sustained during pre-season training. Therefore, these results reinforce the need for adequate and complete rehabilitation programmes during both the closed and pre-season periods.

A limitation of this study was that players from only one football club were included and the patterns observed may only be a reflection of this particular club.
Similar investigations involving a larger sample of teams are required. In addition, changes in the present club’s coaching staff and practices over the study period may have influenced these results. Furthermore, the first reported muscle strain over the course of the study was used as the index injury (as done in previous studies that reported data on football re-injuries). It is possible that this index injury was not the first sustained by some players thereby some results may be confounded. Finally, the incidence of muscle strains may be under- or over-estimated as exposure time in training was calculated on a group basis and time spent by first-team players in occasional reserve team competition was not included. Future research should also be conducted to identify the specific muscles within regions (e.g. hamstring group) that are commonly affected by strain re-occurrences which was not done in the present study. Nevertheless, the strength of this investigation is its four-season span and prospective nature. Furthermore, the methodology generally respects internationally recommended injury recording systems specifically developed to evaluate re-injury in football allowing the results to be compared to current and future research into muscle strain reoccurrences.
References


Table 1: Characteristics of muscle strains and muscle strain reoccurrences

<table>
<thead>
<tr>
<th>Region</th>
<th>N° (%)</th>
<th>Incidence (95% CI)</th>
<th>Mean absence</th>
<th>N° (%)</th>
<th>Incidence (95% CI)</th>
<th>Mean absence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamstring</td>
<td>33 (22.9)</td>
<td>0.99 (CI 0.65-1.33)</td>
<td>8.7 ± 7.4</td>
<td>17 (38.6)</td>
<td>0.51 (CI 0.27-0.75)</td>
<td>7.5 ± 5.6</td>
</tr>
<tr>
<td>Quadriceps</td>
<td>32 (22.2)</td>
<td>0.96 (CI 0.63-1.29)</td>
<td>7.1 ± 4.1</td>
<td>6 (13.6)</td>
<td>0.18 (CI 0.14-0.32)</td>
<td>4.0 ± 1.9</td>
</tr>
<tr>
<td>Lower-leg</td>
<td>28 (19.4)</td>
<td>0.84 (CI 0.53-1.15)</td>
<td>5.4 ± 4.5</td>
<td>9 (20.5)</td>
<td>0.27 (CI 0.09-0.45)</td>
<td>8.2 ± 7.4</td>
</tr>
<tr>
<td>Groin</td>
<td>23 (16.0)</td>
<td>0.69 (CI 0.41-0.97)</td>
<td>8.8 ± 7.7</td>
<td>9 (20.5)</td>
<td>0.27 (CI 0.09-0.45)</td>
<td>9.1 ± 8.7</td>
</tr>
<tr>
<td>Abdomen</td>
<td>14 (9.7)</td>
<td>0.42 (CI 0.20-0.64)</td>
<td>7.6 ± 6.6</td>
<td>2 (4.5)</td>
<td>0.06 (CI -0.02-0.14)</td>
<td>8.0 ± 1.4</td>
</tr>
<tr>
<td>Pelvis</td>
<td>10 (6.9)</td>
<td>0.30 (CI 0.11-0.49)</td>
<td>9.6 ± 8.0</td>
<td>1 (2.3)</td>
<td>0.03 (CI -0.03-0.09)</td>
<td>2.0 ± 0.0</td>
</tr>
<tr>
<td>Back/Neck</td>
<td>4 (2.8)</td>
<td>0.12 (CI 0.00-0.24)</td>
<td>2.8 ± 0.5</td>
<td>0 (0.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>144 (100)</td>
<td>4.31 (CI 3.61-5.01)</td>
<td>7.5 ± 6.4</td>
<td>44 (100)</td>
<td>1.32 (CI 0.93-1.71)</td>
<td>7.5 ± 6.3</td>
</tr>
</tbody>
</table>

Incidence = Number of injuries per 1000 hours exposure time.
95% CI = 95% Confidence Intervals.
Mean absence = Mean number of days according to the number of days the player was absent from and unable to take full part in training or competition.

Figure 1: Frequency of early reoccurrences of muscle strains sustained per week within a period of 8-weeks after the index injury.
Figure 2: Seasonal distribution of muscle strains and muscle strain reoccurrences.

June/July = Pre-season training period and friendly matches.
August to May = Official competitive season including a two-week winter break in mid-December.