

# Muscle injuries of the dominant or non-dominant leg in male football players at elite level

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Received: 31 January 2016 / Accepted: 7 June 2016 / Published online: 23 June 2016  
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## Abstract

**Purpose** The aim was to study possible differences of muscle injuries regarding type, localization and the extent of injury between the dominant and non-dominant leg in elite male football players. Another aim was to study the injury incidence of muscle injuries of the lower extremity during match and training.

**Methods** Data were consecutively collected between 2007 and 2013 in a prospective cohort study based on 54 football players from one team of the Swedish first league. The injury incidence was calculated for both match and training, injuries to the hip adductors, quadriceps, hamstrings and triceps surae were diagnosed and evaluated with ultrasonography, and their length, depth and width were measured to determine the extent of structural muscle injuries.

**Results** Fifty-four players suffered totally 105 of the studied muscle injuries. Out of these 105 injuries, the dominant leg was affected in 53 % ( $n = 56$ ) of the cases. A significantly greater extent of the injury was found in the dominant leg when compared with the non-dominant leg with

regard to structural injuries of the hamstrings. No other significant differences were found.

**Conclusions** Structural hamstring muscle injuries were found to be of greater extent in the dominant leg when compared with the non-dominant leg. This new finding should be taken into consideration when allowing the football player to return to play after leg muscle injuries.

**Level of evidence** IV.

**Keywords** Muscle tear · Soccer · Sonography · Strain · Ultrasound

## Introduction

Football is one of the most popular sports worldwide. Unfortunately, football players are highly exposed to injuries and muscle injuries are the most common ones. According to Fuller et al. [10], muscle injuries represent 31 % of all injuries in football, with hamstring muscle injuries being the most frequent ones followed by the hip adductors, quadriceps and triceps surae. Ninety-two per cent of all muscle injuries occurred in the lower extremity.

During the last decades, different muscle injury classifications have been suggested [18, 20, 21]. Based on the latest knowledge about muscle injuries, a classification system in order to develop a universally applicable terminology has been published [16]. Mueller-Wohlfahrt et al. [16] are suggesting two main categories, indirect and direct muscle injuries. Direct muscle injuries consist of contusions and lacerations, while two subcategories of indirect muscle injuries, functional or structural muscle injuries, are suggested.

Ultrasound, computed tomography or magnetic resonance imaging is often used as a complement to

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clinical examination for diagnosing muscle tears [14]. On the images from an ultrasound examination, it is possible to detect the localization of the damage, fluid accumulation and discontinuity of muscle fibres. It is also possible to measure the extent of the muscle injury in terms of its length, width, depth and cross-sectional area [19].

Ultrasound examination has been suggested to be performed between 2 and 7 days after a muscle injury has occurred [15]. The extent of a muscle injury determined with ultrasound has an impact on the time to return to sport, the larger the injury the later the return to sport [2, 7].

Side differences of muscle function have been reported in football players [3]. The explanation of this phenomenon has been suggested to be due to that football is a sport with different demands of the dominant and non-dominant leg meaning that injuries may not occur evenly between legs [3]. Hitherto only a few studies have made comparisons of muscle injuries between the dominant and non-dominant leg.

The definition of side dominance differs between studies or is not well defined in the literature. In the present investigation, the dominant leg was defined to be the leg that the football player primarily prefers to use when kicking the ball.

The aim of the present investigation was to study possible differences regarding type, localization and the extent of muscle injuries between the dominant and non-dominant leg in elite male football players. Another aim was to study the injury incidence of lower extremity muscle injuries during both match and training. The hypothesis was that muscle injuries more often occur in the dominant leg than in the non-dominant leg among elite male football players.

## Materials and methods

The present clinical investigation is a prospective cohort study of male football players from one team of the Swedish first league. The players consisted of five goalkeepers, 21 defenders, 18 midfielders and nine forwards. All players in this team were asked about participation in the present study, and each one of the players agreed to participate. Whenever a new player joined the team, he was also asked about participation.

### Inclusion/exclusion criteria

Included were ultrasound verified muscle injuries of the hip adductors, quadriceps, hamstrings and/or the triceps surae. Excluded were direct muscle injuries (contusions, lacerations), chronic tendinopathies and injuries that occurred outside of the scheduled activities with the team [11]. Muscle injuries in ambidextrous players and re-injuries were

also excluded. Furthermore, re-injuries, defined as an injury to a previously injured muscle group within the same year of the first injury, were excluded [10]. In total, 271 medical charts were retrieved. Based on the inclusion and exclusion criteria, 105 injuries remained for statistical analysis.

### Procedure

Data of the muscle injuries were collected consecutively during seven seasons (2007–2013).

A total of 54 players sustained a unilateral muscle injury and were included in the study. Out of these 54 injured players, 40 players (74 %) sustained a muscle injury of their dominant leg (right leg) and 14 players of their non-dominant leg (left leg). A muscle injury was defined as either traumatic or due to overuse leading to inability to fully participate in training or match [8].

### Ultrasound examination

All studied muscle injuries were evaluated and diagnosed with ultrasound within 2–7 days after the trauma [15]. Prior to the ultrasound examination, the radiologist, an expert on musculoskeletal ultrasound examination, was informed about which leg and muscle group that was injured. All injuries were examined by the same radiologist, who had 21 years of experience in assessing muscle injuries by the use of ultrasound, which therefore should support a high reliability of the ultrasound examination [4, 5]. The ultrasound equipment My Lab 70 Xvision Esaote SpA (Florence, Italy) was used. The assessment was conducted in two planes, transversely with respect to the muscle fibres and longitudinally in the muscle's longitudinal axis. A linear high-frequency transducer LA 435 (6–18 MHz) was used. Length, depth and width of the haematoma of the affected muscle were recorded. The size of the haematoma consisted of increased echogenicity with or without disruption of muscle fibres, and comparisons with the contralateral uninjured side were made.

The present study was approved by the Regional Ethics Committee at Linköping University, Sweden (Dnr 2010/365-31).

### Statistical analyses

All variables were summarized with frequency (number of structural and functional injuries), or mean and standard deviation (e.g. volume of a structural injury). Muscle injuries that did not show any structural damage on the ultrasound examination were classified as functional muscle injuries. A missing value of any length measurement of a structural injury was replaced by the mean of existing measurements, an unbiased estimate, so that volume of the injury could be

**Table 1** Ultrasound verified length, width, depth and volume of muscle injuries

Measure	Muscle	<i>n</i>	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
CC length	Hip Adductors	9	2.6	1.2	1	5
	Quadriceps	10	4.0	1.3	2	6
	Hamstrings	25	2.4	1.3	0.7	6
	Triceps surae	16	3.3	1.6	1.5	7
	All muscles	60	3.0	1.5	0.7	7
<i>T</i> width	Hip adductors	9	0.9	0.5	0.4	2
	Quadriceps	10	1.3	0.4	0.9	2
	Hamstrings	25	0.8	0.4	0.2	2
	Triceps surae	15	0.9	0.6	0.1	2.5
	All muscles	59	0.9	0.5	0.1	2.5
AP depth	Hip adductors	9	1.5	0.6	0.8	2.5
	Quadriceps	10	1.9	0.7	1	3
	Hamstrings	25	1.4	0.7	0.3	2.5
	Triceps surae	15	2.0	0.8	0.8	3.3
	All muscles	59	1.6	0.7	0.3	3.3
Volume	Hip adductors	9	2.2	2.5	0.4	8.4
	Quadriceps	10	5.8	4.3	1.3	13.0
	Hamstrings	25	2.1	2.6	0.0	9.4
	Triceps surae	15	4.0	4.7	0.1	18.3
	All muscles	59	3.2	3.7	0.0	18.3

Length measurements are expressed in cm and volume in cm<sup>3</sup>

*n* the results are reported as number of injuries, *M* mean, *SD* standard deviation, *Min* minimum, *Max* maximum, *CC length* cranial–caudal length, *T width* transverse width, *AP depth* anterior–posterior depth

calculated ( $n = 3$ ). One player had missing registrations of both width and depth and was regarded as a missing value in the calculation of volume. The volume of the injury was calculated according to the formula  $[\pi/6] \times \text{CC depth} \times T \text{ width} \times \text{AP length}$  [19]. Relationships between categorical variables such as leg dominance and type of injury were analysed with Pearson's  $\chi^2$  method. If an expected cell frequency was  $<5$ , the  $\chi^2$  method was replaced by Fisher's exact test. Differences between groups in continuous variables (e.g. volume) were analysed with Student's *t* test, after the distribution of the variable was checked for severe deviations from a normal distribution. The variable volume was positively skewed and, thus, analysed with a nonparametric Mann–Whitney *U* test. All football players in the same team who met the inclusion criteria were included in the statistical calculations. The significance level in all analyses was 5 % (two-tailed).

## Results

### Injury incidence

The injury incidence of the studied leg muscle injuries during seven seasons (2007–2013) was found to be on an average 12.9 muscle injuries/1000 h of match play and 3.1 muscle injuries/1000 h of training.

Descriptive data of the muscle injuries are presented in Table 1.

### Type of injury

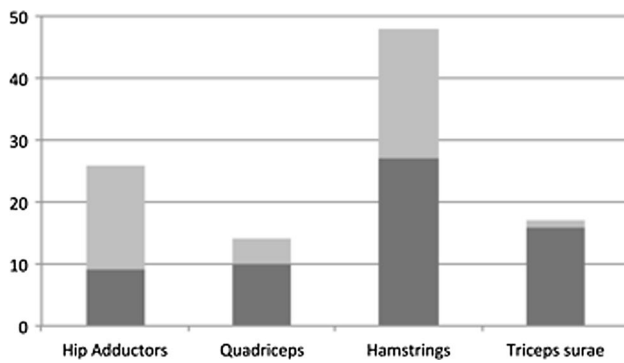
No significant difference was found between the dominant and non-dominant leg in terms of type of muscle injury, functional or structural ( $\chi^2 = 0.313$ ,  $df = 1$ ), as well as in any of the studied muscle groups (hip adductors, quadriceps, hamstrings and triceps surae). The number and distribution of functional and structural muscle injuries in the four studied muscle groups are presented in Fig. 1.

### Injury localization

Fifty-three per cent of all muscle injuries (95 % CI 44–63 %) occurred in the dominant leg. No significant difference between legs was found in terms of injury localization in any of the studied muscle groups ( $\chi^2 = 5.711$ ,  $df = 3$ ; Table 2).

### The extent of injury

No significant difference was found between the dominant and non-dominant leg in terms of the length of injury ( $t(58) = 0.79$ ) as well as in any of the studied muscle groups (hip adductors, quadriceps, hamstrings and triceps surae).



**Fig. 1** Number and distribution of functional and structural muscle injuries within each studied muscle group of the lower extremity. The light grey area represents functional muscle injuries and the dark grey area structural muscle injuries

**Table 2** Localization of muscle injuries of the dominant leg

Muscle	Dominant leg	95 % CI
Hip adductors	11 (42.3)	22–63 %
Quadriceps	10 (71.4)	44–98 %
Hamstrings	23 (47.9)	33–63 %
Triceps surae	12 (70.6)	46–95 %

The results are reported as number of injuries (*n*) and per cent (%)  
CI confidence interval

**Table 3** Volume (cm<sup>3</sup>) of structural muscle injuries of the dominant and non-dominant leg for each muscle group

Muscle	<i>N</i>	Side	<i>M</i>	<i>SD</i>	<i>p</i> value
Hip adductors	4	Dominant	1.7	1.3	n.s
	5	Non-dominant	2.6	3.3	
Quadriceps	7	Dominant	6.9	4.6	n.s
	3	Non-dominant	3.4	2.8	
Hamstrings	12	Dominant	2.9	2.8	0.044
	13	Non-dominant	1.4	2.2	
Triceps surae	10	Dominant	2.5	2.0	n.s
	5	Non-dominant	7.1	7.2	

*N* number of injuries, *M* mean, *SD* standard deviation

The extent of structural injuries to the hamstring muscles was significantly greater in the dominant leg (mean  $2.9 \pm 2.8$ ) compared with the non-dominant leg (mean  $1.4 \pm 2.3$ ) ( $p = 0.04$ ; Table 3). No significant differences were found between the dominant and non-dominant leg in terms of the extent of injuries to the hip adductors, quadriceps and triceps surae (Table 3). Data of muscle length, width, depth and volume are presented in Table 1.

## Discussion

The most important finding of the present investigation was that a greater extent of structural hamstring muscle injuries was found in the dominant leg in comparison with the non-dominant leg. Structural muscle injuries have been reported to require a longer time than functional injuries before returning to play [6, 7]. Therefore, it is valuable to know whether a football player has sustained a structural or a functional muscle injury. The lay-off time can differ from eight up to 73 days depending on the extent of the injury [7]. Therefore, this result should above all be addressed to clinical practitioners when considering return to play.

During the seven studied seasons, the injury incidence of the soccer players was found to be considerably higher during matches than training. When it comes to training, these findings are in line with those reported by Ekstrand et al. [9]. However, during match Ekstrand et al. [11] reported an incidence of muscle injuries to be more than twice as high as in the present study. One possible explanation of these study differences during match play could be that the study by Ekstrand et al. [9] included professional football players at a higher level, UEFA, than our players at the Swedish first league. The higher the level, the greater the physical demands on the player which may be a risk factor for injuries.

Solely somewhat more muscle injuries occurred in the dominant leg compared with the non-dominant leg. The majority of the quadriceps injuries occurred in the dominant leg, and these findings are in line with those reported by Hägglund et al. [12]. Due to shooting and passing, quadriceps might be more exposed to risky events during both training and match. Hägglund et al. [12] later reported that not only quadriceps but also the hip adductors were injured more frequently in the dominant leg than in the non-dominant leg. Hölmich et al. [13] reported a higher number of injuries to the hip adductors in the dominant leg compared with the non-dominant leg. However, hamstring injuries were distributed equally to the dominant leg and the non-dominant leg.

An important study limitation is that the ultrasound examinations were performed at different times after injury meaning that one football player was examined with ultrasound 2 days after injury and another player 7 days after his injury. This might have had an impact on structural injuries, since the extent of the injury usually becomes reduced over time [1]. The amount of the haematoma is maximal after 24 h and already decreases after 48 h [17]. However, according to suggestions and guidelines by Järvinen et al. [15], the ultrasound examination should be carried out 2–7 days after injury.

The muscle injuries were analysed within their own subgroups. This means that another study limitation is the somewhat small number of injuries of each one of the four different muscle groups. A higher number of players may have led to a more clear result.

All ultrasound examinations were performed by an experienced radiologist, thereby eliminating the risk of inter-observer variability [5]. This could be considered a great methodological benefit and strength of the study. In addition, a uniform population, i.e. one team sharing the same clinicians, a physiotherapist and a radiologist, during the data collection most likely increases the methodological consistency.

Inherently, since each individual player was acting as his own control, the present study design is not as vulnerable to unknown confounding factors as many other cohort studies. Factors such as age, general fitness, time of exposure for training as well as match and time of the season should not be seen as possible confounders. However, confounders within the dominant and non-dominant leg should be considered, for instance impaired muscle strength and muscle flexibility and/or muscle imbalance problems.

From a clinical point of view, the result of the present study mainly points out the importance of diagnosing the type of hamstring injuries since a structural muscle injury usually requires a later return to play than a functional muscle injury. Moreover, the extent of a muscle injury also is important regarding the time to return to play, the larger the injury the later the return to play [2, 7].

## Conclusions

In conclusion, in elite male football players a structural muscle injury of the hamstrings was found to be greater in the dominant leg than in the non-dominant leg. No significant differences between the dominant and non-dominant leg were found regarding the extent of injuries to the other studied muscle groups of the lower extremity.

**Acknowledgments** The Swedish Centre for Sport Research is gratefully acknowledged for financial support.

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