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Comparison of Muscle Damage in Turkish Collegian Soccer Players after Playing Matches on Artificial and Natural Turf Fields

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ABSTRACT The researchers have attempted to compare muscle damage in soccer players after matches played on artificial and natural turf fields. The study was performed on 16 male soccer players. A match was played on an artificial turf field, and another one was played on a natural turf field.Visual analogue scale scores, myoglobin, creatine kinase, aspartate transaminase and lactate dehydrogenase levels were measured before the match, after the match and at the 72nd hour. The 2x3 repeated measure ANOVA test was performed for statistical analysis. Comparing the artificial turf and natural turf field values, the post-match and 72nd hour visual analogue scale scores for artificial turf field were found to be statistically significant and higher than the natural turf field values. Based on these findings, the researchers claim that muscle damage is not significantly different when comparing matches played on both fields.

INTRODUCTION

Soccer is the most popular sport of the modern era and is played by millions of people. Wright and Webner (2010) claimed that classically, soccer was played on natural turf fields, but due to low utilization, impact of cold and rainy climates, quick wear and high cost of maintenance of natural turf fields, more artificial turf fields were built. For these reasons, the first generation of artificial turf fields in the 1960s, which were made of concrete and covered with short fibers, were replaced with fields made of rubber and sand filling, covered with long fibers and with thick fractured stone laid on the ground (Dragoo and Braun 2010; Wright and Webner 2010**)**. As the third generation artificial turf fields are almost produced with the same characteristics as natural turf fields, the Federation Internationale de Football Association has allowed matches to be played on such fields. Today, many games are played on artificial turf.

Bangsbo et al. (2006) suggested that aerobic and anaerobic energy systems are used together in soccer. A soccer player runs about 11,000 meters depending on her position on the field and heads the ball about 6-12 times (Di Salvo et al. 2007; Rampinini et al. 2007; Lipton et al. 2013). Slow running, fast running, running backwards, running sideways, jumping, passing the ball control, dribbling, and short and long passes are frequently performed in soccer matches. During these activities, many muscle groups perform eccentric, concentric, isometric and plyometric

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contractions. Both male and female soccer players are known to experience tiredness, muscle fatigue and muscle damage after matches (Ascensao et al. 2008; Ascensao et al. 2011; Gravina et al. 2011; Silva et al. 2013). Nybo et al. (2013) suggested that muscle pain, reduced power, muscle rigor, increased creatine kinase (CK), myoglobin (MYO), aspartate aminotransferase (AST) and lactate dehydogenase (LDH) levels are the most significant indicators of muscle damage.Taylor et al. (2013) suggested that even though the characteristics of artificial turf fields are now close to those of natural turf fields, there is still a difference in terms of footwear-ground interaction and flexibility coefficients. Some publications report no significant difference between natural and artificial turfs in terms of fatigue and physiological response (Hughes et al. 2013; Stone et al. 2014). Whereas Andersson et al. (2008) reported that soccer players who train on natural turf fields have adaptation difficulties when playing matches on artificial turf fields. Moreover, it is known that soccer players complain more about muscle damage and fatigue after training and playing matches on artificial turf fields.

Objectives

There are various studies comparing the risk of post-match injuries between artificial and natural turf fields (Aoki et al. 2010; Meyers 2013). Nevertheless, the researchers did not find any studies comparing post-match muscle soreness and damage between artificial and natural turf fields. The goal is to compare muscle damage from playing on artificial and natural turf fields.

MATERIAL AND METHODS

Subjects

In this study, 22 amateur soccer players were enrolled. Six players were excluded because they did not meet the inclusion criteria. Two players were goalkeepers. Two other players were injured. Another player did not submit his blood sample following the match on the natural turf field. Another player did not comply with the resting period. In the end,16 players whose mean statistics were 21.95 years old, 176.19 cm, 74.06 kg and 23.89 BMI values were included in the assessment. Players, who play in the Erciyes University Soccer Team, train and play matches on artificial turf fields.

The researchers obtained permission from the Erciyes University Ethics Committee, and performed the study according to the Helsinki Charter. Soccer players were informed about the study, their permission obtained, and they were split into two teams.

Procedures

Initially, a match was played in dry and warm weather (24-26 ºC) on a third generation artificial turf field under FIFA rules. The same teams played a second match two weeks later under the same weather conditions on a natural turf field. The players used the same equipment in both matches, did warm- up, exercised and stretching for 20 minutes pre-match and cool down and stretching post-match. Matches were played under the supervision of a coach to ensure that players exert maximal and equal effort during both matches. Moreover, a heart rate monitor was used to keep the exercise intensity at the same stable level. Heart rate was measured during both matchesand recorded every 5 seconds (Polar Team[2], Finland). The teams had three non-training days before and after both matches. During this period, the players were instructed not to train, take medicine or nutrition supplements or change their nutrition in order to reduce or eradicate the effect of confounding variables.

Measurements

Visual analogue scale (VAS) scores were recorded for soreness of the lower extremity muscles (quadriceps and hamstring) 30 minutes before the matches, 30 minutes after the matches and at the 72nd hour after the matches. Football players were asked to mark muscle pain of the front and rear side of their legs on a scale of 0-100.Blood samples were collected from the antecubital vein (10 cc) 30 minutes before the matches, 30 minutes after the match and at the 72nd hour, then the serums were separated by centrifuging them for 10 minutes at 1500 x g and stored at -80 ºC until the time of analysis. In order to prevent pre-analytic errors during blood sampling, the same phlebotomist collected the samples and the tourniquet time was kept below 1 minute. CK, AST and LDH levels were measured spectrophotometrically using an Olympus AU

2700 (Beckman-Coulter, USA) chemical autoanalyzer. MYO level was measured using an Access 2 (Beckman-Coulter, USA) immunochemical autoanalyzer.

Statistical Analysis

Mean and standard deviation values were calculated for data with a normal distribution. For other VAS values, a median and interquartile range of the 25th and 75th percentiles was taken. The 2x3 repeated measure ANOVA test was performed for pre-match, post-match and 72nd hour comparison of artificial and natural turf field results. Bonferrony post-hoc tests were employed to determine the level of significance.The statistical significance levelwas taken as $p< 0.05$.

RESULTS

The mean heart rates for artificial field and natural field matches were 167.30 and 164.70 bpm respectively and did not show any statistically significant difference. Post-match VAS, MYO, CK, AST and LDH values were found to be significantly higher compared to pre-match values for artificial turf and natural turf fields. The 72nd hour values were found to be statistically significantly lower compared to post-match values. There was no statistically significant difference between the 72nd hour values and pre-match values, except for the VAS score for the artificial turf field (See Table 1). Post-match and 72nd hour VAS scores for the artificial turf field were statistically significantly higher than post-match scores for the natural turf field (See Fig. 1) whereas CK, MYO, AST and LDH values were not statistically significantly different (See Figs. 2 and 3).

DISCUSSION

Various studies report that muscle injury starts 24-48 hours after eccentric exercise, and makes a peak at 24-72 hours and attenuates and resolves on day 5-7 (Saka et al. 2009; Yanagisawa et al. 2010; McKune et al. 2012; Kanda et al. 2013). It is also known that football players have fatigue-related muscle soreness and muscle injury after the match. (Ascensao et al. 2008; Saka et al. 2009; Ascensao et al. 2011; Gravina et al. 2011). Nedelec et al. (2012) reported that muscle injury is one of the causes of fatigue in football players. Souglis et al. (2015) showed that muscle

Table 1: The comparison of natural and artificial turf field values at pre-match, post-match and 72th hour

n:16	Artificial turf			Natural turf			p		
	Pre-match	*Post-match*	*72nd hour*	*Pre-match*	*Post-match*	*72nd hour*	*Time*	*Group x time*	*Group*
VAS	0.00 (0-0)[a,c]	50.00 (40-60)[a,b]	10.00 (10-9)[b,c]	0.00 (0-0)[a]	27.50 (15-40)[a,b]	0.00 (0-5)[b]	0.001	0.001	0.001
MYO	23.44± 5.57[a]	82.49± 7.17[a,b]	24.58 ± 6.08[b]	20.93 ± 5.67[a]	82.40± 31.39[a,b]	21.19 ± 5.36[b]	0.001	0.621	0.920
CK	151.38±42.96[a]	279.75±105.03[a,b]	153.69± 60.19[b]	165.00 ± 58.55[a]	241.5± 79.26[a,b]	165.75± 75.33[b]	0.001	0.853	0.536
AST	21.25± 3.64[a]	24.25± 3.96[a,b]	21.19 ± 2.48 [b]	19.56 ± 4.46[a]	22.56 ± 5.18[a,b]	19.69 ± 5.26[b]	0.001	0.245	0.981
LDH	176.38± 7.26[a]	199.75± 27.53[a,b]	176.63± 31.58[b]	153.38 ± 29.68[a]	179.94± 26.79[a,b]	140.94± 26.32[b]	0.001	0.504	0.337

VAS: visual analogue scale (it is given as median and interquartile range of 25th and 75th percentiles). MYO: myoglobin (nanogramme/mililitre), CK: creatine kinase (unit/litre), AST: aspartate transaminase (unit/litre), LDH: lactate dehydrogenase (unit/litre)
a.The difference between pre-match and post-match results are statistically significant within group (P<0.05).
b.The difference between post-match and 72nd hour results are statistically significant within group (P<0.05).
c.The difference between pre-match and 72nd hour results are statistically significant within group (P<0.05).

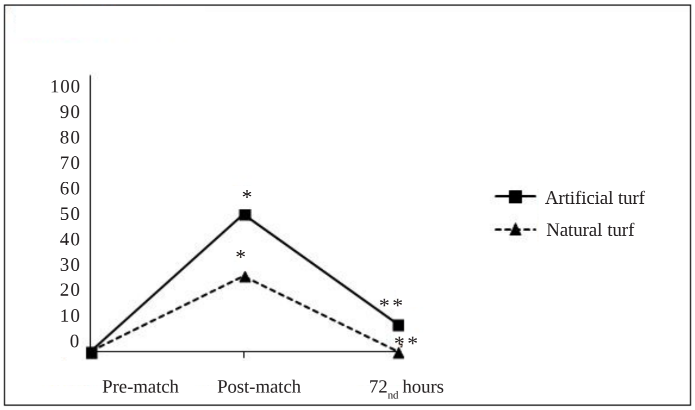

Fig. 1. VAS scores

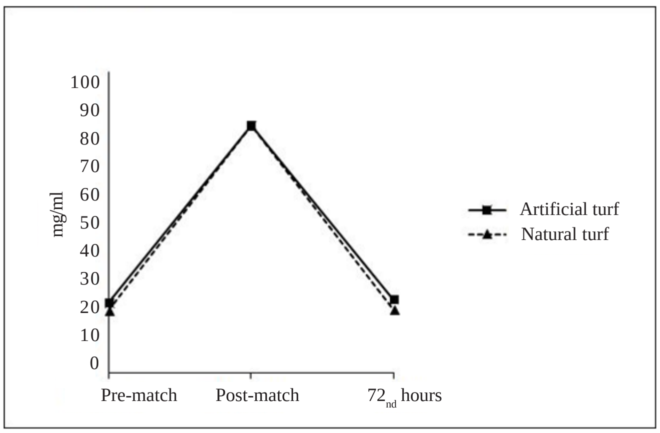

Fig. 2. Myoglobin values

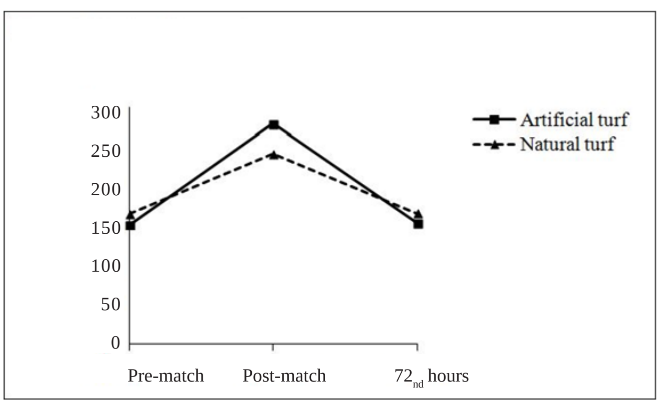

Fig. 3. Creatine kinase values

injury parameters were two-fold higher post-match versus pre-match peaking at hour 13 and decreasing in 37 hours. In this study, also, muscle injury parameters increased post-match and normalized in 72 hours.

Delayed onset muscle soreness (DOMS) is one of the most significant findings of muscle damage and is frequently measured by VAS. Davies et al. (2011) suggested that DOMS starts around 24 hours after eccentric exercise, and peaks at 48 hours. Ispirlidis et al. (2008) identified a peak of DOMS in 24 hours post-match.The results indicate that DOMS starts immediately post-match and decreases at the 72^{nd} hour. However, the post-match VAS score for the artificial turf field was statistically significantly higher than the post-match VAS score for the natural turf field. Moreover, VAS values at hour 72 in the artificial turf were found higher compared to grass turf. This indicates increased and prolonged DOMS after artificial turf matches.

Di Michele et al. (2009) found that more lactate was accumulated on third generation artificial turf fields at the same speeds when compared to natural turf fields and treadmill. Additionally, they detected higher heart rates at a 10 km/h speed on artificial turf fields. These results show that artificial turf demands higher performance at the same running speed and induces a quicker onset of fatigue. Although lactate values were not measured, the results of this study indicate more muscle soreness associated with artificial turf. Davies et al. (2011) found that the VAS score increased by fifty percent after eccentric exercises were performed, and muscle damage due to exercise caused a decrease in creatine phosphate and exercise tolerance by modifying the muscle damage metabolism. Del Coso et al. (2012) reported that leg muscle power decreased and muscle damage parameters increased during the Half Iron Marathon, that there was a correlation between CK and MYO increase and leg muscle power decrease, and that muscle damage was one of the reasons for fatigue in the triathlon. These findings show that fatigue after soccer matches can be caused by muscle damage.

One of the indirect indicators of muscle damage in the blood is an increase in CK. Even though CK has different isoenzymes, the researchers measured total CK in the study for economical reasons. The post-match CK values in the results were significantly higher for both artificial and natural turf fields. Thorpe and Sunderland (2012) identified an average of seventy four percent increase of CK after a grass turf match, which was correlated with the sprint amount. CK values in the study are parallel to the above study. Barnes et al. (2010) reported that muscle damage occurs after eccentric exercise, and CK level reaches its maximum level in the first 24 hours and decreases after 48 hours. However, Barnes' study included isolated eccentric exercise. Thus, no parallelism with the above study should be expected.

McKune et al. (2012) suggested that MYO, another indicator of muscle damage, increases and decreases early compared to CK in activities with intense eccentric contractions as a result of muscle destruction. Ascensao et al. (2011) reported that MYO values that rise after soccer matches decrease after 24 hours and MYO and CK values decrease by diving into cold water. Silva et al. (2013) reported that MYO increases after 24 hours. Nybo et al. (2013) reported that MYO values increase after a match and return to normal levels after 24 hours.Thorpe and Sunderland (2012) identified a two hundred and thirty-eight percent increase of MYO value post-match. These results are in agreement with the researchers' results. MYO values meaningfully increased after matches on both fields, but returned to normal levels after 72 hours. However, the researchers did not find a difference in MYO values between artificial and natural turf fields.

AST and LDH are less specific enzymes used to detect muscle damage. They showed an increase after artificial and natural turf field matches, but decreased to normal levels in 72 hours. The researchers did not find a meaningful difference in the AST and LDH levels for either field type. Other indicators of muscle damage such as, power loss, range of motion limitation or inflammatory parameters were not tested in this study.

The lack of difference in CK, MYO, AST, LDH values between artificial and natural turf fields can be explained by soccer players having a history of exercising on artificial turf fields. As a matter of fact, Paschalis et al. (2013) reported that muscle damage developed as a result of eccentric exercise, but that repeating the exercise a second time decreased muscle damage and developed adaptation. Neme Ide et al. (2013) reported that muscle damage decreased by repeating sets and adaptation was observed.This came to light when an amateur soccer team which has always played on a natural field was transferred to an artificial field, the results showed that muscle damage decreased by repeating sets, and adaptation was observed; this team was used as a control group. But the researchers could not find an amateur soccer team that only trained on natural turf fields.

CONCLUSION

One can say that muscle damage and muscle soreness occur after football matches on both artificial and natural turf fields, muscle damage was not found to be significantly different between both fields, whereas muscle soreness was significantly more severe after a match on the artificial turf field and resolved later versus the natural turf field.

RECOMMENDATIONS

A football team that trains on grass turf may experience muscle soreness when playing on artificial turf. This is why training on artificial turf fields will also be of help.

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LIMITATIONS

Factors such as position in the league table, opponent's performance and motivation can affect soccer players' performance, and therefore potential muscle damage. In order to reduce the impact of these parameters, both matches were played as friendlies. It is not realistic to attribute muscle damage only to the type of field. This study could have been performed with activities specific to football on artificial and natural turf fields, thereby minimizing parameters that might affect muscle damage. However, the researchers' aim was to simulate a soccer match with all its characteristics, and this is why they performed the study in this way. The number of subjects was low, that might be another limitation. However, the team comprised 22 players. Including several teams in the study could have increased the number of players.

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