Return to training following match-play: implications of the metabolic stress levels of the player

Introduction and Purpose

Soccer players at the elite level experience varying levels of physical stress depending on the training programme, match schedules and involvement with International and domestic teams. Measures of external load are commonly estimated using GPS systems during training and camera-based systems during match-play, giving an important indication of the physical exertion of each individual player, which can be used by Medical and Fitness staff to manage the training and recovery loads of the players effectively. Measures of internal stress can be more difficult to quantify, but can provide an important indication of the individual response of the players to the external load. One such method is to quantify the stress resulting from the internal metabolic processes brought on by the volume and intensity of training or match-play. Metabolic, or oxidative stress (OS) occurs in the cells, body fluids and tissues following varying intensities of exercise, resulting in the production of reactive nitrogen and oxygen species, with implications for mitochondrial biogenesis, glucose transport and muscle hypertrophy (1). Soccer match-play represents a significant physical stress on the player, for which the external load can be estimated using camera-based systems. However, the individual internal response to the external load can be influenced by a myriad of physical, psychological, biochemical and mechanical factors which make quantification of the internal stress difficult. Therefore the monitoring of OS may enable the identification of fatigues states, under-performance and illness, thus helping the Medical and Fitness staff to manage the players appropriately.

The purpose of this preliminary study was to gain an understanding into the oxidative stress profiles of a group of regularly-playing elite level soccer players, with the aim of using a series of case-studies to investigate whether changes in OS following match-play have any implications for the management of the player. With an enhanced understanding of the individual response to the training and match load, we theorise that it is possible to identify when a player is close to their tolerance limit, or has an underlying illness or infection that could impact on their ability to perform maximally.

Methods

Subjects

Ten professional soccer players (mean ± SD; age 25.9 ± 2.7 years; height 179.6 ± 7.3cm; body mass 80.4 ± 6.8kg) from an English Championship Club were monitored for levels of Oxidative Stress (OS) throughout the pre-season phase, and following four competitive matches in the first half of the season in which all players played >85 mins.

Blood Sampling

Whole blood capillary samples (20µL) were taken from the players' ear lobes, processed and analysed immediately at room temperature in line with the manufacturer's instructions

(Callegari SpA, Catellani Group, Parma, Italy). This involves the heparinized samples being mixed immediately with the reagent, centrifuged for one minute and analysed colorimetrically using the Callegari CR3000 device.

Biochemical Analysis

The presence of reactive oxygen species was determined indirectly through the test, which is a colorimetric assay based on the capacity of transition metal ions (Fe3+ /Fe2+) to catalyze the breakdown of hydroperoxides (R-OOH) into derivative radicals [alkoxyl (R-O) and peroxyl radicals (R-OO)] within the biological sample. The application of an acidic buffer to the 20µL capillary sample releases the transition metals from associated proteins, which react with the hydroperoxides present in the sample, producing the alkoxyl and peroxyl radicals. The derivative radicals are trapped through the addition of a buffered chromogen and develop into a radical cation in a linear based reaction at a controlled temperature of 37°C, photometrically detectable at 505nm. The intensity of the sample colour correlates with the quantity of radical compounds and therefore the concentration of hydroperoxides in the biological sample, according to Lambert- Beer's law. The results are expressed as equivalent concentrations of H_2O_2 mmol.L^{-1}.

Study Design

All players were tested 3 times on separate days during the pre-season phase with the aim of identifying a baseline OS value which could indicate a 'healthy' level for the player. These were following a rest-day, and not within 72hrs of a competitive match. The average of the 3 scores was used as the individual baseline. During the in-season phase, between September – November 2016, four games were available where the 10 players with a calculated baseline had played >85 minutes in the same competitive matches (players who didn't have a calculated baseline or who played in fewer games were excluded from the study). On the day following match-days, players reported to the training ground where the capillary blood samples were taken between 9.30-10.00am, and before the player had eaten breakfast or exercised on that day. Samples were analysed immediately at room temperature.

Results

Mean OS levels after matches (mean ± SD; 1.56 ± 0.31mmol.L^{-1}) did not differ significantly from baseline levels (mean ± SD; 1.55 ± 0.25mmol.L^{-1}), with an average change of +1.8%. However, three players recorded significantly higher OS scores after a match (max OS score [% change from baseline]; Player 1: 1.94 mmol.L^{-1} [+32.9%]; Player 9: 1.76 mmol.L^{-1} [+24.8%]; Player 10: 2.4 mmol.L^{-1} [+41.2%]). This is shown in Figure 1.

Conclusions

Changes in OS following competitive matches were minimal for the majority of players, and likely had minimal physiological significance. However, in individual cases, high (>24% from baseline) increases in OS were observed, which were concurrent with the presence of an upper-respiratory tract infection (Player 10), reporting a high level of soreness from a chronic soft-tissue injury (Player 1), and following an incident where the player reported in-game sickness and digestive discomfort and was substituted before the end of the game (Player 9). Changes in OS markers may therefore have implications for safe return-to-play following matches, given that elevated levels may be concurrent with underlying

issues that may limit performance and recovery potential. Long-term tracking of OS levels across a season may help in the training load management of players during intense periods of fixture congestion, and as part of the overall picture of an injury prediction model.

References

Lewis N, Newell J, Burden R, Howatson G, Pedlar C. Critical difference and biological variation in biomarkers of oxidative stress and nutritional status in athletes. PLoS ONE 2016;11(3): e0149927

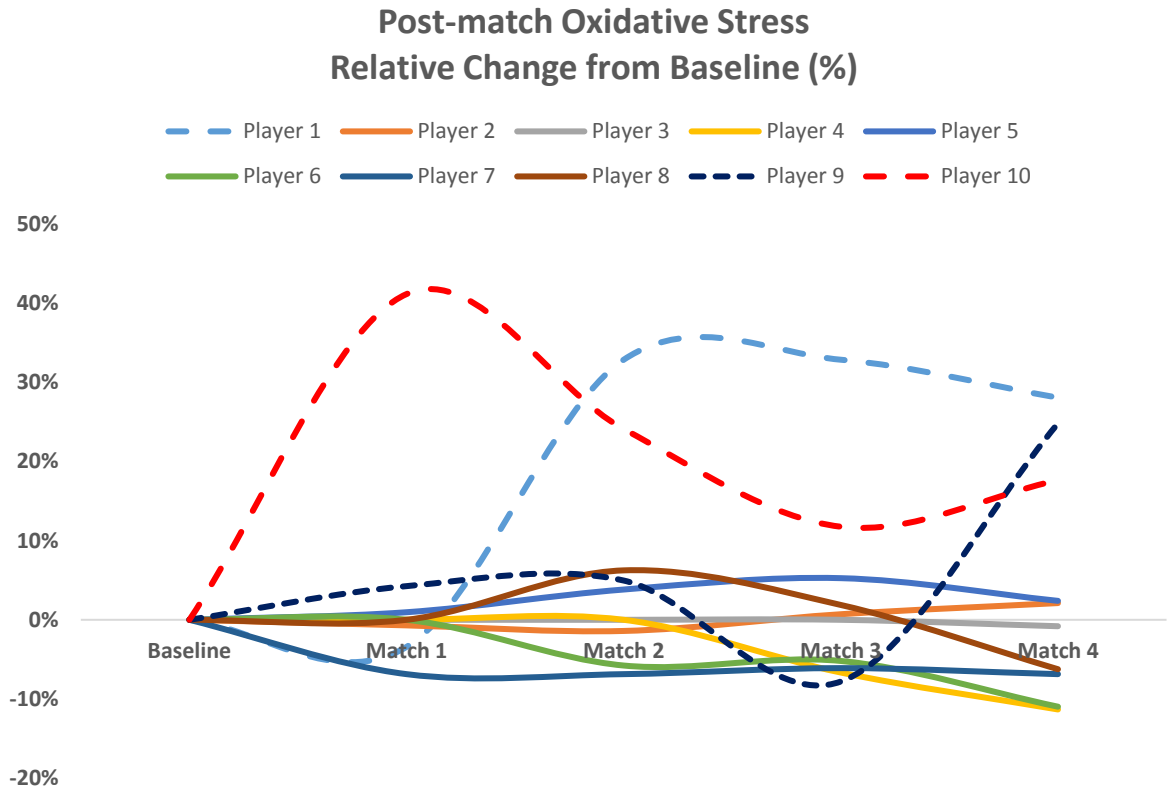

Figure 1 - Oxidative stress following matches (percentage change from measured baseline)