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The Influence of Handball Simulated Competition Induced Fatigue on Functional Stability

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ABSTRACT

The aim of this study was to quantify the influence of competition-induced fatigue on functional stability in professional handball players. 20 male professional handball players (age 25.3±1.4 yr, body mass 70.3±2.7 kg, VO2max 61.2±2.2 ml kg) completed a 60 min simulated competition protocol replicating the activity Profile of match-play with a 10 min passive (rest) interval. At 10 min intervals players completed a 30 s single-legged balance task on an unstable biodex platform (level 3). Balance performance was quantified as a stability index and the mean deflection of the platform. Results showed no significant (P>0.05) main effect for exercise duration in the stability index, suggesting that balance performance was maintained throughout the competition. However, the mean deflection of the platform was significantly (P<0.05) shifted toward anterior displacement during the last 10 min of the protocol. There wasn't significant relationship between lactate acid accumulation and variations of stability indices (r =-0/661, p<0.05). A change in balance strategy was evident during the last stages of protocol, which may increase the risk of injury. Therefore, the improvement of proprioception in the ankle and knee joint is recommended as a prevention role to the injuries in the abovementioned joints.

Keywords: handball, Fatigue, Stability, performance, Balance, joint position sense.

INTRODUCTION

Fatigue is a complex phenomenon that can be described as a time-dependent exercise-induced reduction in the maximal force generating capacity of a muscle [1]. Alteration in performance tends to vary across sports that are influenced more or less by factors like decreased muscular power and endurance, decreased motor skill performance, and mental lapses. It is well known that impairment of performance resulting from neuromuscular fatigue differs according to the type of contraction, the muscular group tested and the exercise duration/intensity [2]. Therefore, the muscular fatigue can be the result of a failure in any process involved in the muscular contraction [3]. Historically, the potential factors involved in the fatigue development are divided in two categories: the central factors that should provoke the fatigue by a disorder in the neuromuscular transmission between the Central Nervous System (CNS) and the muscular membrane, and peripheral factors that would cause an alteration inside the muscle [4, 6]. Another characteristic of the fatigue is the fact that it depends on the task, that is, its causes vary in a very wide way, and it behaves according to the way it is induced [3,7]. The muscular fatigue is considered as a predisposing factor to the appearance of injuries [8, 9], such as the ankle sprain. Surenkok et al (2006) showed that there was no correlation between lactic acid accumulation and stability changes. It can be concluded that knee muscle fatigue has an adverse effect on balance; however, this impairment was not correlated with the degree of lactic acid accumulation [11].

Several authors have been studying the effects of the muscular fatigue on the neuromuscular control[8,14-16], which is related to the proprioceptive afferents that are taken by the peripheral receptors to the upper centers, and to the efferent (motor) responses generated with the purpose to keep the dynamic muscular stability[17]. Studies have shown that the muscular fatigue causes an adverse change in the proprioception [15, 18] a sensorial modality comprising the sensations of the joint movement and positioning [12], as well as the postural control [8, 14, 16, 19]. Stability is defined as the ability to maintain intervertebral and global torso equilibrium despite the presence of small mechanical disturbances and/or small neuromuscular control errors. Stability of the spine may be impaired by fatigue of the paraspinal muscles [20]. Etiological risk factors associated with joint sprain injury incidence and severity [21] include impaired proprioceptive capacity [22, 2] and postural stability [23, 3]. Rozzi et al (2000) suggested that in the fatigued state the joint may fail to produce the appropriate muscular responses which have a protective function in maintaining joint stability [24]. The aim of the present study was to examine the influence of handball simulated competition induced fatigue on single-legged balance performance among Iranian elite male handball players.

MATERIALS AND METHODS

Twenty professional male handball players (age 25.3±1.4 yr, body mass 70.3±2.7 kg, VO2max 61.2±2.2 ml kg min) participated in this study. VO2 max was determined by breath-by-breath analysis of a laboratory- based graded treadmill protocol to volitional failure. All participants provided written informed consent prior to beginning the study. Subjects were tested between 18:00 and 20:00 h, according to the regular training or competition times, and to account for the effects of circadian variation [25, 1]. Participants attended the laboratory in a 3-h post-absorptive state, having performed no vigorous exercise in the 24 h prior to testing, and with diet standardized for 48 h proceeding in each test. Players were required to consume 500 ml of water 2 h prior to testing to ensure dehydration. Thereafter the subjects consumed no fluid so as to control for the possible influence of hydration status on performance [1].

Players completed the intermittent handball– specific fatigue protocol[1]. Pre-exercise, and at 10 min intervals throughout the exercise protocol, each player completed the balance task to assess dynamic balance. The balance task was administered using the Biodex stabilometer (Biodex Medical Systems, New York, USA).

All subjects completed familiarization trials of the balance task in the rested state on a minimum of three previous laboratory visits. The stabilometer trial comprised a 30 s single-legged balance task where the subject was instructed to keep the dynamic and unstable platform level to the best of their ability. Subjects balanced on their dominant leg (identified bye the forward pushing test; researcher pushed athletes forward then, first leg that subjects were used for balance control in additional step come dominant leg). During the balance task each player was instructed to look directly ahead, with slight flexion at the knee, equivalent to the stork stance. A difficulty level of 3 on Biodex was applied to all tests. No visual feedback was provided to the subject with regard to performance. Furthermore the lactate scout (production of Sense Lab Company) used to measure the lactate acid accumulation. For this reason the middle finger blood sample were used (at initiation and after the protocol). Subjects participated in the handball test. Before and immediately after the fatigue protocol, blood lactic acid levels measured. Blood samples were collected from unpreferred hand mid-fingertips two times [1) immediately prior to the handball protocol (pre-lac), 2) and five minutes after the last 10 min of the protocol. For the purpose of estimating blood lactate using a lactate analyzer (Analox P-LM55, UK) found in an Analox lactate kit supplied by Analox (UK). It should be noted that, the analyzer had been calibrated with known lactate standards (5.0 and 15.0 mM). Since environmental conditions can affect blood lactate levels and performance [13], air temperature and relative humidity values for the track were recorded (21.4 ± 1.4°C and 50.2 ± 7.1%, for first sessions) using an Arco device (Model TC14P; Germany) and then single-leg balance measured after each 10min handball training protocol. Indices of stability were quantified as an overall

[1] . Intermittent handball– specific fatigue protocol was a handball playing in short time that each of the handball techniques were executed with players in intermittent 10 min.

measure, and also in both the anterior–posterior and medio-lateral planes. The same directional indices were quantified for the mean deflection over the duration of the balance task. Task performance was quantified at 10 min intervals throughout the competition protocol, including at the start and end of the passive half-time interval. Pearson correlation coefficient used for evaluation correlation between lactate acid accumulation and variations of stability indices. The main effect for exercise duration was analyzed using Repeated measure ANOVA. Significant differences between means were identified using a post hoc test (TOKEY Test), all results reported as the mean± standard deviation, with significance accepted level at P<0.05.

RESULTS

Table 1. Repeated Measure ANOVA test results for stability indices and Platform deflection

Variables stability indices	df	F	sig
overall stability index	19,7	35.32	0.19
Ant-Post stability index		32.17	0.16
Med-Lat stability index		27.63	0.13
Ant-Post Platform deflection		21.44	0.09
Med-Lat Platform deflection		29.14	0.15

Repeated measure ANOVA test results for stability indices and Platform deflection cited in table 1. The Repeated measure ANOVA test results revealed that there aren't any significant main effects for time in either score. There wasn't significant relationship between lactate acid accumulation and variations of stability indices (r = -0/661, p<0.05).

DISCUSSION

The Repeated measure ANOVA test results revealed that there aren't any significant main effects for time, such that single legged balance performance was maintained throughout the trial. Few studies have directly measured the effects of sport induced specific fatigue on functional stability. Greig et al (2007) indicated that sport specific fatigue couldn't affect stability index by times [1]. Schieppati (2003) completed a study in fatigue mechanisms; they found that fatigue can alter the stability indices [10]. According to this study results there wasn't significant relationship between lactate acid accumulation and variations of stability indices. In this study we found that lactate acid accumulation couldn't affect stability index. One reason for this result is that the professional handball player often training in the lactate threshold (based on energy systems), that this case can improved they body resistance for lactate acid accumulation and therefore the lactate acid accumulation couldn't affect stability index. Also Surenkok et al (2006) showed that there was no correlation between lactic acid accumulation and stability changes. It can be concluded that knee muscle fatigue has an adverse effect on balance; however, this impairment was not correlated with the degree of lactic acid accumulation [11]. In the context of the multisensory control of balance, when the availability or the reliability of input from a particular body location decreases, it is conceivable the central nervous system to increase the weighting of input from other locations that provide reliable information for maintaining stable posture [7]. Consideration of the directional stability indices reveals that stability was greater in the medio-lateral plane than in the anterior–posterior plane, until the post-exercise measure. This might reflect the anatomical configuration of boney and soft tissue structures [26]. Instability in the medio-lateral plane is likely to pose a greater risk for joint injury, and the finding of no fatigue effect with exercise duration suggests that joint stability was not compromised. However, consideration of the mean deflection of the platform over the duration of the task indicates that a change of strategy might have been employed. In each trial the mean deflection was lateral to the centre of the platform, as expected. However, at the end of each half the mean deflection in the anterior-posterior direction was seen to increase in the anterior direction. This toes down rotation of the platform is indicative of greater plantar flexion at the ankle. In a more functional setting plantar-flexion of the ankle reduces the base of support and increases the risk of ankle sprain injury due to the additional rotational and transverse movements allowed towards the more open packed position of the ankle joint [26].

The anterior deflection might also be achieved by increased knee or hip flexion to move the centre of mass forward. Injury risk might be increased when placing greater reliance on knee or hip strategies to maintain balance, due to changes in muscular recruitment patterns. This interpretation is supported by the observations of Adlerton et al (2003) who reported a post-fatigue change in postural control strategy, where the habitual strategy changed from ankle to hip following localized muscle fatigue of the calf. The modifications made in the postural control pattern produce compensatory corrections around the joints to maintain functional stability [27]. However, whilst balance performance is maintained, the fatigue-induced alterations in strategy might make the player more susceptible to injury. The alteration in balance strategy during the latter stages of each half suggests that functional joint stability is impaired during the latter stages of each half. This finding supports epidemiological observations of temporal patterns in ankle sprain incidence during soccer match-play [28]. The nature of the change in balance strategy, i.e. an inverted ankle that becomes increasingly plantar-flexed during the latter stages of match-play, is also correlated to injury epidemiology. Lateral ankle sprain is a common injury, accounting for 25–50% of all injuries in sports [29] and 17% of soccer injuries [30]. Woods et al. (2003)reported that 77% of all ankle ligament sprain injuries were localized to the lateral complex. An inversion force applied to the foot with the ankle in plantar-flexion was described as a common mechanism of injury to the lateral ligament. This scenario is analogous to cutting maneuvers and multi-directional jumping inherent in handball activities. It is not possible to conclusively state the mechanism driving the change in balance strategy during the latter stages of each half. Fatigued muscles have been shown to exhibit extended latency in firing [30], electromechanical delay [28, 29], and slower muscle reaction time [10]. The subsequent impairment of the dynamic stabilizing function of muscles is a primary factor in the non-contact etiology of joint ligamentous injury [30].

CONCLUSION

Stability was maintained and this was seemingly achieved by a change in balance strategy during the latter stages of each half. These stages of the game are therefore when the player is most susceptible to injury. It is suggested that handball players perform proprioception drills both in the rested and exercised state.

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Practical application: this study can be used for evaluation and comparing fatigue & fitness in handball players via their coaches.

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