Ergonomics Intervention Among Football Players

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ABSTRACT

We summarize recent studies to shed some light on the benefit of ergonomic approaches in sports and more specifically in football. In football, the physical demands can lead to muscular pain. Pressure pain mapping can be used as a surrogate for evaluation of the sensory changes in sports. Thus, pressure pain threshold (PPTs) was assessed in a set of studies 1) to compare topographical pressure pain sensitivity maps of the lower extremity in elite footballers playing on artificial turf or natural grass; 2) to investigate specialized recovery training on lower extremities pressure pain sensitivity; 3) to measure the effect of the usage of shock-absorbing insoles on foot PPTs during training among young soccer players on artificial turf. In total of 102 football players participated in these studies. Pressure pain thresholds were measured bilaterally over 23 locations of the lower extremity, including the rectus femoris, tensor fasciae latae, vastus lateralis/medialis; external and internal hamstrings; tibialis anterior; peroneous; external and internal gastrocnemius, and soleus muscles, in a blinded design. Further, PPTs measured at the 1-3-5 metatarsal bones; abductor digiti minimi muscle; flexor digitorum brevis muscle; abductor hallucis muscle, and calcaneus bone. Pain intensity and comfort were assessed using numeric rating scales. Our studies showed that football players playing on natural grass exhibited lower PPTs as compared to those players playing on artificial turf, specialized recovery training results in a decrease of muscles sensitivity 48 hours after game and addition of shock-absorbing insoles resulted in a significantly increased PPTs and reduced pain intensity as compared with playing without insoles.

Keywords: Soccer, Pressure Pain Threshold, Artificial Turf, Recovery Training, Insoles

INTRODUCTION

Training and competition in football should apply an ergonomics approach. Athletes have to optimize their performance in relation to the extreme demands of the modern professional sport. Moreover the interaction between the equipment, training methods and athletes' performance needs to be optimized to obtain the best possible sport results and minimize the risk of injuries. The physical demands inherent to football can lead to muscular pain (Bangsbo, Mohr and Poulsen, 2006). The provoked pain is affected by both the intensity and the duration of the physical exposure (Cheung, Hume and Maxwell, 2003) but these factors are difficult to downscale in football. Pressure pain algometry is the method previously used to assess changes in muscle sensitivity to pressure in

presence of e.g. muscle soreness and pain (Nie, Kawczynski, Madeleine, et al., 2005). In the recent literature, PPTs mapping has been conducted in e.g. the quadriceps muscles (Hedayatpour, Falla, Arendt-Nielsen, et al., 2008), wrist extensors (Fernandez-Carnero, Binderup, Ge, et al., 2010) and trapezius (Kawczynski, Nie, Jaskolska, et al., 2007, Nie, Arendt-Nielsen, Kawczynski, et al., 2007). Investigation of pressure pain thresholds (PPTs) enables to study deep structure changes in pressure pain sensitivity. Moreover, this imaging modality reveals heterogeneously distributed hyperalgesia (Binderup, Arendt-Nielsen and Madeleine, 2010). There is a lack of studies addressing changes in pain perception and physiological responses among football players in relation to e.g. turf types (Potthast, Verhelst, Hughes, et al., 2010). PPTs mapping was used for the first time to investigate changes in mechanical sensitivity over the lower extremities muscles as the effect of pitch surface, recovery training modalities and shock-absorbing insoles.
We investigated that following factors: 1) pitch surface; 2) specialized recovery training; 3) shock-absorbing insoles in relation to pressure pain threshold and comfort or pain intensity.

METHODS

A total of 102 football players participated in these studies. We provide all measurement on the football pitch and general schedule of assessment was aimed to follow players professional activity: 1) in pitch surface research measurements performed before and after playing on artificial and natural grass (Domínguez-Martín, López-Ruiz, Reyes-López, et al., 2013); 2) in recovery training experiment assessment were performed before match, 24 and 48 hours after match (Kawczynski, Mroczek, Frackiewicz, et al., 2014); 3) in shock-absorbing project data were obtained after training on only grass turf for three months and were repeated twice after three weeks on artificial (Kaalund and Madeleine, 2014, Madeleine, Hoej, Fernández-de-las-Peñas, et al., 2014). An electronic pressure algometer (Somedic® Algometer type 2, Sweden) was used to measure PPTs. The diameter of the contact tip was 10 mm and covered with 2 mm thick rubber. A standardized procedure to increase the applied pressure at a constant rate 30 kPa/s was performed during pressure application. Pressure pain thresholds were measured bilaterally over 23 locations of the lower extremity, including the rectus femoris, tensor fasciae latae, vastus lateralis/medialis; external and internal hamstrings; tibialis anterior; peroneous; external and internal gastrocnemius, and soleus muscles, in a blinded design. Further, PPTs measured at the 1-3-5 metatarsal bones; abductor digiti minimi muscle; flexor digitorum brevis muscle; abductor hallucis muscle, and calcaneus bone. Pain intensity and comfort were assessed using numeric rating scales. The PPTs measurements were made to assess changes in PPTs in relation to pitch surface, specialized recovery training and the addition of shock-absorbing insoles. For the influence of the shock absorbing insole, Numeric rating scale anchored “0: best comfort/no pain” and “10: worst imaginable comfort/pain”. The intra-class correlation coefficient (ICC) was used to assess the intra-examiner reliability of PPTs. A multilevel analysis of variance (ANOVA) was used to detect differences in PPTs with group (artificial turf or natural grass) as between subject variable. In specialized recovery training measurements (before, 24 and 48 hours after game) were introduced as within subject factors in a full-factorial repeated measure analysis of variance for the PPTs. For the experiment aimed on shock-absorbing insoles a Mann-Whitney U and two-way ANOVA and two-way repeated measures ANOVA tests were used to compare between groups with and without insoles.

RESULTS

In Dominguez-Martin et al (2013), football players playing on natural grass exhibited lower PPT than football players playing on artificial grass. Moreover, the vastus medialis muscle was the most sensitive whereas the rectus femoris was the least sensitive location investigated in the lower extremity (Domínguez-Martín, et al., 2013).
In Kawczynski et al (2014), a specially- designed recovery training resulted in lower extent of delayed onset muscle soreness (fig. 1)depicted by increased PPTs after league game (Kawczynski, et al., 2014).
In Kaalund & Madeleine (2014) and Madeleine et al (2014), the use of shock-absorbing insoles was also found ergonomically effective as the comfort reported by the young elite players increased. Additionally, the pain intensity decreased significantly and the PPTs increased after three weeks training on artificial grass with shock-absorbing insoles compared with usual insoles (Kaalund and Madeleine, 2014, Madeleine, et al., 2014)

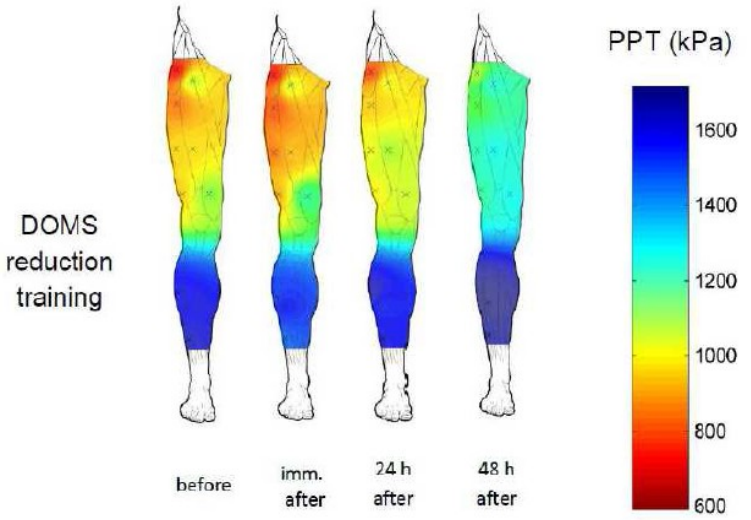

Fig. 1 Example of the absolute pressure pain threshold (PPT) maps of the lower extremities muscles for research aimed at delayed onset muscle soreness (DOMS) reduction training.

CONCLUSIONS

Ergonomics approaches can advantageously contribute to the design of e.g., pitch surface, training regimes and the design of sports equipment. The presented ergonomic interventions aimed in general at increasing the comfort in professional football. Elite clubs may play additional games during a weekly micro-cycle due to participation in local or international tournaments. The demand for playing 2 to 3 games per week elevates the stress imposed to the musculoskeletal structures of the players, thereby increasing the injury risk, performance decline due to fatigue and, muscle damage (Ekblom, 1986). Additional ergonomic research on athletes from e.g. other disciplines targeting the lower extremities or other body regions is clearly needed. The reported findings on pitch surface, specialized recovery training and shock-absorbing insoles in football are of interest to clinicians and researchers interested in human factors issues.

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