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Full Length Article

Compression and texture in socks enhance football kicking performance

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ABSTRACT

The purpose of this study was to observe effects of wearing textured insoles and clinical compression socks on organisation of lower limb interceptive actions in developing athletes of different skill levels in association football. Six advanced learners and six completely novice football players (15.4 ± 0.9 years) performed 20 instep kicks with maximum velocity, in four randomly organised insoles and socks conditions, (a) Smooth Socks with Smooth Insoles (SSSI); (b) Smooth Socks with Textured Insoles (SSTI); (c) Compression Socks with Smooth Insoles (CSSI) and (d), Compression Socks with Textured Insoles (CSTI). Reflective markers were placed on key anatomical locations and the ball to facilitate three-dimensional (3D) movement recording and analysis. Data on 3D kinematic variables and initial ball velocity were analysed using one-way mixed model ANOVAs. Results revealed that wearing textured and compression materials enhanced performance in key variables, such as the maximum velocity of the instep kick and increased initial ball velocity, among advanced learners compared to the use of non-textured and compression materials. Adding texture to football boot insoles appeared to interact with compression materials to improve kicking performance, captured by these important measures. This improvement in kicking performance is likely to have occurred through enhanced somatosensory system feedback utilised for foot placement and movement organisation of the lower limbs. Data suggested that advanced learners were better at harnessing the augmented feedback information from compression and texture to regulate emerging movement patterns compared to novices.

1. Introduction

Textured materials, comprised of raised nodules added to shoe insoles, socks or support surfaces, are hypothesised to enhance sensory input from regions of indentation (Orth et al., 2013). Research has shown that adding texture to the upper surface of shoe insoles provides better mechanical contact and increased sensory afferent feedback via enhanced stimulation

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of cutaneous mechanoreceptors on the plantar surface of the foot (Hatton, Dixon, Martin, & Rome, 2009). Results have revealed that use of these materials can alter joint kinematics and kinetics of the foot (Nurse, Hulliger, Wakeling, Nigg, & Stefanyshyn, 2005) during performance of standing and walking tasks, implying a relatively cheap method for improving perceptual-motor performance, compared to more expensive foot orthotics or vibrating insoles (Qiu et al., 2012). A recent meta-analysis (Orth et al., 2013) suggested that simple deformation of the skin surface by adding texture to insole surfaces can improve performance in fundamental tasks such as balancing and postural regulation. Different types of textured materials (insoles, inserts, socks and surfaces) have been examined in various populations to study their effects on postural stability, foot positioning and locomotion (Chiu & Shiang, 2007; Corbin, Hart, Palmieri-Smith, Ingersoll, & Hertel, 2007; Dixon et al., 2012; Hartmann, Murer, de Bie, & de Bruin, 2010; Hatton et al., 2009; Qiu et al., 2012, 2013; Waddington & Adams, 2003) .

Compression socks have also begun to receive attention from researchers, albeit mostly in investigations of physiological benefits (Ali, Creasy, & Edge, 2010; Blättler & Zimmet, 2008; Kemmler et al., 2009) including blood circulation during sport performance (e.g. in running). However, the role of compression socks in supporting somatosensory feedback (arising from pressure on and contortion of cutaneous surfaces and joint receptors of the lower leg) has received limited attention in the sports science and medicine literature (Woo, Davids, Liukkonen, Jaakkola, & Chow, 2014). In a recent study by Woo et al. (2014), textured compression socks were used by physically active elderly individuals to investigate effects on postural stability. The researchers sought to understand whether the textured components of the socks (comprised of indentations) located at the interface with the soles of the feet, ankles (medial, lateral and posterior sides), and tibia (anterior and proximal sides) would enable exploitation of additional "sensorimotor system noise" in nervous system function, which would, counterintuitively, boost the sensory signals from receptors in the sole of the foot (Davids, Shuttleworth, Button, Renshaw, & Glazier, 2004). The textured surface of the clinical compression socks (including the compressive tightness of the socks too) deforms plantar tissues and enable participants to enhance perception of haptic information for lower limb positioning (Davids et al., 2004). Wearing normal socks (lacking texture and compression) may dampen the noise arising from variable tissue deformation at the foot area compared to when textured compression socks are worn. The use of textured compression socks in the study by Woo et al. (2014) might have enhanced the capacity of pickup and integration of weak and diffuse information signals (Davids et al., 2004) in the nervous system to aid balance and postural control.

Woo et al. (2014) also studied whether the *added* compression feature of socks enhanced stimulation of the mechanoreceptors in the lower leg, with the aim of helping participants achieve better balance control, compared to using textured materials only. Despite higher mechanical pressure from the compression socks (compared to normal socks), almost all participants reported feeling comfortable during the balance tests, indicating that the tightness of the socks (mainly at the ankle and calf areas) had provided them with enhanced somatosensory information. However, the use of the textured-compression socks in the previous study did not produce significant effects on postural control in participants, who were physically active elderly people.

In the current study, the effects of the textured-compression socks were investigated during performance of a more dynamic movement. It was expected that significant changes would emerge in movement organisation of instep kicking due to effects of enhanced somatosensory feedback. We sought to understand whether use of texture and compression may provide athletes, categorised as advanced learners, with an advantage in the regulation of actions in sport, due to their greater attunement to proprioceptive information from limb movements (Fajen, Riley, & Turvey, 2008; Han, Waddington, Anson, & Adams, 2013). To date, there have been few studies undertaken to ascertain effects of wearing such materials on movement patterns in elite and developing athletes in sport. In two previous textured material studies (Waddington & Adams, 2000, 2003) conducted on athletic populations, participants were tested on perceptual discrimination of ankle inversion and eversion movements. Data showed better ankle movement discrimination scores and improved ankle inversion movements among participants (netballers and footballers) due to wearing textured insoles, compared to smooth insoles. However, these findings emerged during performance of static movements (e.g. balance) and it needs to be understood whether enhanced somatosensory system feedback, can be gained from by wearing textured and compression materials, and, if so, whether it can enhance performance of dynamic, multi-articular action like kicking. One study that did investigate performance of recreational athletes on agility task (Miranda et al., 2016) reported better task completion times on the agility test when participants wore sensory information-enhancing insoles. However, the insoles used in that study utilised a power source (cable connected to a computer) which might have limited practical value for participants' performing a dynamic sports skill like kicking a ball.

Kicking is the defining action in association football (Lees, Asai, Andersen, Nunome, & Sterzing, 2010) and a powerful kick is characterised by the achievement of maximum ball velocity (Kellis & Katis, 2007). Previous biomechanical analyses on kicking (Katis & Kellis, 2010; Kellis & Katis, 2007) have investigated types of kicking in association football and the instep kick was observed to be the most suitable technique to achieve a powerful ball velocity compared to other kicks (e.g. outstep). During the foot-ball contact phase of an instep kick performance, the ankle should achieve greater ranges of motion (plantarflexion) to generate maximum ball velocity (Kellis & Katis, 2007; Shan & Westerhoff, 2005; Shinkai, Nunome, Ikegami, & Isokawa, 2008). A previous investigation (Waddington & Adams, 2003) reported improved ankle movements when wearing textured insoles in football shoes. It was expected that effects of enhanced somatosensory feedback when wearing textured insoles and clinical compression socks in this study would reveal improved ankle movements (a greater plantarflexed position) during the foot-ball contact phase in generating maximum ball velocity.