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Lecture

Military personnel with self-reported ankle injuries do not demonstrate deficits in dynamic postural stability or landing kinematics

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ABSTRACT

Background: The odds of sustaining non-contact musculoskeletal injuries are higher in Special Operations Forces operators than in infantry soldiers. The ankle is one of the most commonly injured joints, and once injured can put individuals at risk for reinjury. The purpose of this study was to determine if any differences in postural stability and landing kinematics exist between operators with a self-reported ankle injury in the past one year and uninjured controls.

Methods: A total of 55 Special Operations Forces operators were included in this analysis. Comparisons were made between operators with a self-reported ankle injury within one-year of their test date ($n = 11$) and healthy matched controls ($n = 44$). Comparisons were also made between injured and uninjured limbs within the injured group. Dynamic postural stability and landing kinematics at the ankle, knee, and hip were assessed during a single-leg jump-landing task. Comparisons were made between groups with independent *t*-tests and within the injured group between limbs using paired *t*-tests.

Findings: There were no significant differences in dynamic postural stability index or landing kinematics between the injured and uninjured groups. Anterior-posterior stability index was significantly higher on the uninjured limb compared to the injured limb within the injured group ($P = 0.02$).

Interpretation: Single ankle injuries sustained by operators may not lead to deficits in dynamic postural stability. Dynamic postural stability index and landing kinematics within one year after injury were either not affected by the injuries reported, or injured operators were trained back to baseline measures through rehabilitation and daily activity.

1. Introduction

Musculoskeletal injury is a significant health concern for the United States military resulting in lost duty time, disability, hospitalization, high healthcare costs, and ultimately impacts military readiness (Jones et al., 2000; Lauder et al., 2000). The odds of sustaining a traumatic injury (tear or rupture) to the shoulders, knees, or legs are six times greater in Special Operations Forces (SOF) operators than in infantry soldiers (Reynolds et al., 2009). Over 75% of non-contact musculoskeletal injuries reported by SOF operators are related to physical training and sports (Abt et al., 2014; Reynolds et al., 2009). The majority of injuries occur in the lower extremity with the ankle joint being one of the most commonly injured joints among Navy SOF operators (Kaufman et al., 2000) and airborne soldiers (Kragh et al., 1996; Lillywhite, 1991; Sell et al., 2010). In an isolated, acute ankle sprain, individuals are often able to return to activity quickly (Medina McKeon et al., 2014). However, residual sensorimotor (Gribble et al., 2016; Hertel, 2008), postural stability (Doherty et al., 2015a; Doherty et al., 2016a; Goldie et al., 1994; Wikstrom et al., 2010), and functional movement (Doherty et al., 2015c; Doherty et al., 2016c) deficits may persist up to one year following acute injury. Individuals have an increased risk of reinjury during the first year after an ankle sprain and may go on to develop chronic ankle instability (CAI) (Bahr and Bahr, 1997; Doherty et al., 2016b). It is important to understand the residual effect of a single self-reported ankle sprain on dynamic postural stability and landing patterns to refocus rehabilitation efforts for mitigation of recurrent

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injury.

Postural stability is defined as the ability to sustain the body in equilibrium by maintaining the projected center of mass within the limits of the base of support (Shumway-Cook and Woollacott, 2001). It is a dynamic process that requires afferent detection of body motion, integration of sensorimotor information within the central nervous system, and execution of an appropriate response in order to maintain the body in equilibrium (Riemann and Lephart, 2002a; Riemann and Lephart, 2002b). Acute ankle sprains have been associated with postural stability deficits during a single-leg stance and Star Excursion Balance Test (Doherty et al., 2015a; Doherty et al., 2016a; Goldie et al., 1994; Wikstrom et al., 2010). A single-leg jump landing task has been shown to identify dynamic postural stability deficits in individuals with CAI (Brown et al., 2010; Brown et al., 2015; Wikstrom et al., 2007; Wikstrom et al., 2012). However, the effects of a single self-reported ankle sprain on dynamic postural stability measures during a single-leg jump landing task are unknown. Dynamic measures of postural stability are preferred for military and athletic groups as they are more challenging than static tasks and may better differentiate between risk factors in healthy, physically active individuals (Sell et al., 2012).

Landing mechanics play an important role in force attenuation during jump landing tasks (Doherty et al., 2015c). Positioning of the hip, knee, and ankle during the landing phase contributes to the body's ability to absorb impact forces and recover stability during dynamic tasks (Devita and Skelly, 1992; Doherty et al., 2015c). Following first time acute lateral ankle sprain, individuals display increased hip flexion and ankle inversion on the injured limb (Doherty et al., 2015b; Doherty et al., 2015c). Though there is limited research on landing strategies following acute lateral ankle sprain, Doherty et al. suggest the changes observed are similar to movement patterns exhibited by individuals with CAI (Doherty et al., 2016c). Unilateral injury has been shown to affect bilateral performance (Doherty et al., 2015b; Doherty et al., 2016c), and Hass et al. suggest this may be due to central changes and may increase risk of future injury (Hass et al., 2010). While few studies have observed landing kinematics during a dynamic postural stability landing task (Delahunt et al., 2006), a change in landing strategy associated with a deficit in dynamic postural stability may offer insight regarding which functional movement patterns to address during rehabilitation to improve stability.

The effect of a single self-reported ankle injury on dynamic postural stability and landing mechanics during a dynamic postural stability task is unknown in a military population. While most single sprain incidents are perceived to minimally impact function, there is evidence suggesting these incidents might be significant enough to alter landing kinematics and dynamic postural stability (Doherty et al., 2015a; Doherty et al., 2015c). The purpose of this study was to determine if SOF operators with a previous ankle injury display differences in dynamic postural stability and landing mechanics compared to uninjured controls. We also compared these factors between the injured and uninjured limbs of those SOF operators with a self-reported ankle injury. We hypothesized that SOF operators that reported a previous ankle injury would have deficits in dynamic postural stability on their injured limb compared to their uninjured limb and compared to the control group. We also hypothesized that SOF operators with previous ankle injury would demonstrate increased hip flexion and knee extension on their injured limb at initial contact compared to their uninjured limb and compared to the control group which may expose them to a greater risk of reinjury (Gehring et al., 2013; Terada and Gribble, 2015). The results of this study may offer support for supplementing current rehabilitation and physical training with balance training for SOF operators who report ankle injury to reduce the risk for future lower extremity injury.

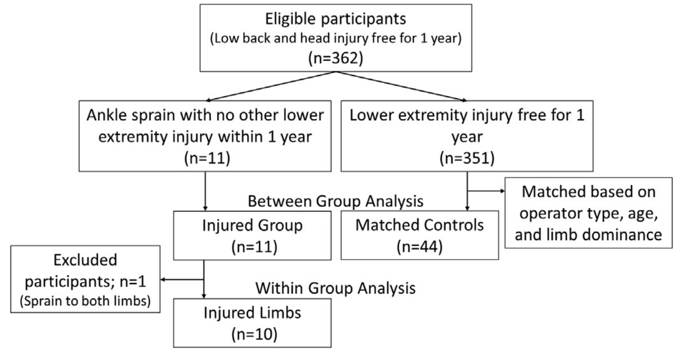

Fig. 1. Flow chart of eligible participants based on self-reported history and matched controls.

2. Methods

2.1. Participants

SOF operators from Air Force Special Operations Command (AFSOC), United States Army Special Operations Command (USASOC), and Naval Special Warfare (NSW) candidates were recruited and tested at Warrior Human Performance Research Laboratories, onsite research laboratories operated by personnel from the University of Pittsburgh. The University of Pittsburgh's Department of Sports Medicine and Nutrition has an ongoing research collaboration with multiple SOF groups designed to reduce the risk of injury and enhance performance of SOF operators. Several factors are considered as part of this effort including retrospective and prospective injury data, biomechanical, neuromuscular, physiological, and nutritional data. This study reports on a small subset of the data collected.

All operators and candidates enrolled in the ongoing research collaboration had been cleared for full duty and were free of self-reported musculoskeletal injury in the previous 3 months. A subset of 362 operators and candidates were included in this study and reported no low back or head injuries within one year prior to test date (Fig. 1). Eleven of the 362 enrolled had a self-reported history of ankle injury within one year prior to their test date and reported no additional lower extremity injuries within that one year period. The rest of the participants reported no lower extremity injuries within one year prior to test date and were included in the initial pool of potential participants to serve as the control group. The control group was narrowed by randomly selecting matched controls at the group level in a 1:4 ratio of injured to control limbs (Hennessy et al., 1999). Demographics for control and injured groups are listed in Table 1. Limbs were matched based on operator type (i.e., AFSOC, USASOC, NSW), age, and limb dominance. Participants were matched for age based on the following groupings: 20–28 years 29–36 years, i.e., for a give injured participant, matched controls would have to fall within the same age grouping. Limb dominance was determined by asking the participant which leg they would prefer to use to kick a ball (Lephart et al., 2002). For the side-to-side comparison, one participant was excluded due to injury to both ankles within one year prior to test date. All participants gave written consent approved by the University of Pittsburgh Institutional Review Board.

Table 1
Subject demographics.

	Injured (n = 11) Mean (SD)	Uninjured matched controls (n = 44) Mean (SD)	P value
Age (yrs)	27.5 (5.2)	26.1 (4.3)	0.48
Height (cm)	176.2 (8.9)	178.8 (7.3)	0.35
Mass (kg)	85.5 (11.8)	84.9 (9.6)	0.80