TITLE: Effects of Non-Compressive Recovery Leg Sleeves on Time-Loss in Professional Soccer Players

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ABSTRACT

Background: Soccer players commonly sustain leg injuries that result in lost time from games and practice. To enhance recovery, professional athletes have begun wearing recovery sleeves; however, there is a paucity of data on their effectiveness. The purpose of this study is to evaluate the effects of non-compressive recovery leg sleeves on time-loss in professional soccer players.

Methods: Injury reports from a North American professional soccer team were retrospectively compared between two consecutive competitive seasons. None of the players wore a recovery sleeve during the first "No-Sleeve" season. During the second "Sleeve" season, all players wore non-compressive recovery leg sleeves (Incrediwear®) according to a prescribed protocol. Differences in events, games, and days missed between the seasons were analyzed. Estimated cost savings were calculated.

Results: For lower extremity injuries, there were significantly fewer days ($p=0.037$), games ($p=0.005$), and events ($p=0.004$) missed in the Sleeve season. For lower extremity soft tissue only injuries (sprain, strain, pain, tightness, and soreness), players in the Sleeve season missed significantly fewer games ($p=.007$) and events ($p=.004$).

Conclusions: The use of recovery leg sleeves may have a beneficial impact in helping reduce time-loss in professional soccer players following lower extremity soft tissue injuries.

Key Words: soccer, lower extremity injuries, recovery

INTRODUCTION

Lower extremity muscle injuries are common and costly amongst soccer players, with muscle injuries representing up to 37% of all injuries resulting in time loss in professional male soccer athletes (Eckstrand et al 2011, Walden et al 2005). Based on this, a professional soccer team could expect 15 muscular-related injuries for a 25-man roster in one season (Eckstrand et al 2011). Between 87% to 92% of all muscular injuries in professional soccer teams are in the lower extremity (Eckstrand et al 2011; Hawkins et al 2001). Nearly one-third of all time lost from game play in professional soccer clubs is due to muscular injuries (Eckstrand et al 2011). Time-loss has been shown to have significant financial ramifications for soccer organizations. For the English Premier League's 2015/2016 season, it was estimated that across all teams a loss of 157.4 million pounds (197 million US dollars) was sustained due to time-loss from games (jlt.com 2019).

To assist in the treatment of lower extremity soft-tissue injuries, compression wear is commonly used by athletes to promote recovery. While previous research focusing on compression wear has yielded mixed results (Weakley et al 2022, Sperlich et al 2010, Ménétrier et al 2011), there is little to no research on non-compressive recovery wear and its role in recovery for lower extremity injuries in the professional soccer realm. Therefore, the purpose of this study is to evaluate the effects of non-compressive recovery leg sleeves on time-loss for professional soccer players recovering from a lower extremity injury.

Materials and Methods

Design and Participants

This retrospective investigation was approved by the Institutional Review Board (University of Southern California).

Injury reports from a North American male professional soccer team were retrospectively compared between two consecutive competitive seasons (2015 and 2016). None of the players wore a recovery sleeve during the first "No-Sleeve" season, as the sleeve was not available to the athletes during this season. During the second "Sleeve" season, all players on this team wore non-compressive recovery leg sleeves (Incrediwear®) according to a prescribed standard protocol.

The certified athletic trainers for this team performed all evaluations and data collection of the players over the course of the two seasons. The data was divided into two groups, one for all lower extremity injuries sustained which included bone injuries (Table 1) and the other for lower extremity soft tissue (ST) only injuries (Table 2). Soft-tissue injuries were defined by the athletic training staff as strains, sprains, muscle soreness and muscle tightness. Events, games, and days were defined by the athletic training staff as follows: sanctioned events were activity based (e.g., game, practice, friendly games), games were any official scheduled game, and days were the number of days that the athlete was injured from the first day post-injury until the athlete was cleared to return to play, which was determined by the athletic training staff and team physicians.

Intervention

Both the No-Sleeve season and the Sleeve season followed a standard recovery protocol implemented by the athletic training staff for all athletes who met the following criteria (Appendix A):

i. Sustained a musculoskeletal injury to the lower extremity (determined by athletic training staff)

i. Experienced 10% or higher than their normal training load in distance, high speed running, and/or accelerations/decelerations that day (determined by athletic training staff)

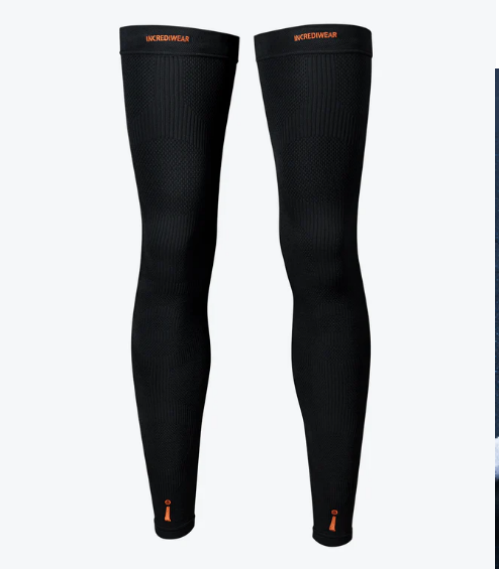
The additional intervention for the Sleeve season included the use of the non-compressive recovery leg sleeve in conjunction with the standard recovery protocol that was already in place. The criteria for the use of the recovery leg sleeve were as follows:

i. Injured athletes (minimum 1 hour before and 1 hour after events/practice/games)
ii. All travel days
iii. Post-training: those 10%+ over their norm in distance, high speed running, and/or accelerations/decelerations don recovery leg sleeves minimum 1 hour after training.

The recovery leg sleeve used was a product of Incrediwear, Inc. (www.incrediwear.com; Chico, CA, USA). The leg sleeve is embedded with carbonized charcoal and germanium (Figure 1). Germanium is a nontoxic semiconductor metalloid located between tin and silicone in the periodic table. Semiconductors such as germanium differ from metals in that as the temperature of semiconductors increases, their resistance decreases. This is a result of germanium having more "free" electrons at certain temperatures, allowing for a higher conductivity. It is theorized that embedding germanium into cotton garments is an effective way to use the transdermal effect to create a micro electromagnetic field, leading to increased circulation and affecting the inflammatory process (Marino et al 2019, Lee et al 2018).

Figure 1.

Incrediwear Leg Sleeve



www.incrediwear.com

Main Outcomes and Measures

Missed events, game, and total days lost due to all lower extremity injuries including bone injuries and lower extremity ST-only injuries were recorded. T-tests compared the averages of missed events, games, and total days between the No-Sleeve and Sleeve seasons in all lower extremity injuries and lower extremity ST-only injuries. Alpha level was set at $p \leq 0.05$. Cohen's D was measured to demonstrate the strength of the difference between means.

Results

The soccer team had 25 active players on the roster. In the No-Sleeve season, the team had 30 total injuries, resulting in 512 missed events and 723 missed days. Ten injuries (33%) included concussion, bone, or meniscus. In the Sleeve season, the team had 28 total injuries, resulting in 194 missed events and 388 missed days. Two injuries (7%) included fractures. Excluding these two fracture injuries, the total days missed in the

Sleeve season was 249 days. Table 1 shows descriptive statistics of the time-loss injuries between the No-Sleeve season and the Sleeve season. between the two seasons that separate all lower extremity injuries including bone injuries and lower extremity soft tissue (ST) injuries only, respectively. Table 1 details that for all lower extremity injuries, significantly fewer mean games were missed (M = 1.16, p = .012) and events were missed (M = 5.88, p = .021) in the Sleeve season compared to the No-Sleeve season, where mean games (M = 4.04) and events (M = 17.72) were missed. Mean days missed decreased from 25.48 days in No-Sleeve season to 11.92 days in the Sleeve season for all lower extremity injuries but failed to reach statistical significance (p = .051).

Table 1.— *Lower Extremity Injuries including Bone Injuries; No-Sleeve Season vs. Sleeve Season*

	No-Sleeve Season Lower Extremity Injuries	Sleeve Season Lower Extremity Injuries	P-Value	Cohens D
Sample Size (n)	25	25		
Mean Games Missed	4.04 (5.11)	1.16 (2.10)	0.012*	0.78
Mean Events Missed	17.72 (22.74)	5.88 (10.00)	0.021*	0.68
Mean Days Missed	25.48 (30.63)	11.92 (14.32)	0.051	0.56

() = standard deviation, * = $p < 0.05$

Table 2 shows that for lower extremity ST-only injuries, significantly fewer mean games were missed (M = 0.74, p = .012) and events were missed (M = 3.74, p = .007) in the Sleeve season compared to the No-Sleeve season, where mean games (M = 2.53) and mean events (M = 11.12) were missed. Mean days missed for lower extremity ST-only injuries decreased from 15.94 days in the No-Sleeve season to 9.09 days in Sleeve season but failed to reach statistical significance (p = .052).

Table 2.— *Lower Extremity Soft Tissue-Only Injuries; No-Sleeve Season vs. Sleeve Season*

	No-Sleeve Season Lower Extremity ST-Only Injuries	Sleeve Season Lower Extremity ST-Only Injuries	P-Value	Cohens D
Sample Size (n)	17	23		
Mean Games Missed	2.53 (3.04)	0.74 (1.01)	0.012*	0.67
Mean Events Missed	11.12 (11.96)	3.74 (2.68)	0.007*	0.89
Mean Days Missed	15.94 (15.51)	9.09 (4.79)	0.052	0.6

ST = soft tissue, () = standard deviation, * = $p < 0.05$

Mean time-loss resulting from lower extremity injuries is shown in the figures below, categorized between all lower extremity injuries including bone injuries in Table 3 and into lower extremity ST-only injuries in Table 4. As shown in Table 3, athletes who wore the recovery leg sleeves in Sleave season missed significantly fewer mean games and events than in No-Sleeve season. When the data is narrowed to lower extremity ST-only injuries in Table 4, the average amount of time-loss due to injury in the Sleeve season was still significantly less than the No-Sleeve season.

Discussion

Many studies have looked specifically at compression wear and its relation to musculoskeletal injuries and their effect on recovery (Valle et al 2013; Davies et al 2009); Duffield et al 2010). Compression garments have been found to be effective enhancing blood flow and in reducing the post-exercise levels of intracellular albumin and lymphocytes that are associated with delayed onset muscle soreness (DOMS) (O'Riordan et al 2022, Valle et al 2013). Compression garments have also been utilized post-plyometric training, demonstrating some success with reduced ratings of perceived muscle soreness and blood levels of creatine kinase and aspartate transaminase, but no effect on

the performance of the athletes across groups (Davies et al 2009; Duffield et al 2010). Non-compressive recovery wear, specifically germanium-embedded sleeves, have been shown to improve pain and functional outcomes in patients with knee osteoarthritis (Marino et al 2019). No studies to date have assessed non-compressive sleeves and their effect on recovery time following injury. The findings of our study demonstrate that the players from the Sleeve season missed significantly fewer games and events following all lower extremity injuries and following lower extremity ST-only injuries when compared to the No-Sleeve season, with the only significant change in recovery protocol was the addition of the non-compressive recovery leg sleeves. It is important to note that both seasons had the same number of lower extremity injuries recorded but mean time-loss due to injury was lower with the addition of the recovery leg sleeves. The ability to use a method of recovery that is both passive and effective has a significant importance that is two-fold. Firstly, the health of the athlete and the ability to return to play as quickly as possible to reduce loss of endurance, strength and their overall cardiovascular capacity is primary. Secondly being a financial benefit for the athletic club, allowing their player to return to high performance for their team rather than remaining on an injury report. The average player salary in the MLS is $386,668 (https://soccerprime.com/mls-player-salary/). The typical season in the MLS is comprised of 34 games (revolutionsoccer.net). If one average MLS player misses one game, that equates to a financial loss of $11,372 for the team. The projected financial loss of games from lower extremity ST-only injuries during the Sleeve season (0.74) would equate to $8,415, compared to the financial loss of games during the No-Sleeve season (2.53) of $28,771, yielding a potential financial recovery of $20,371.

According to the product description of the non-compression garments used in this study, these garments improve blood circulation without compression

(www.incrediwear.com/pages/about). One prior study demonstrated improvements in pain scores and outcome scores in patients with early knee osteoarthritis when wearing knee sleeves with the same fabric (Marino et al 2019). While these garments are not designed to provide compression, the actual pressure produced by these garments were not measured and is currently unknown. It has been found that ratings of perceived muscle soreness were significantly reduced in those wearing lower extremity compression wear compared to a control, which could be another explanation for the effectiveness of the garments (Davies et al 2009). It is possible that the recovery sleeves used in the present study may have had this same effect, although ratings of perceived muscle soreness were not measured. An explanation for the improvement observed between seasons has been previously postulated to be due to improvements in facilitating the removal of the concentration of damage markers in the blood, including creatine kinase (Davies et al 2009).

A potential limitation of this study is the inability to differentiate significant differences between lower extremity injuries and lower extremity ST-only injuries. This is likely due to the small difference in sample size when the groups are narrowed down from lower extremity injuries to specifically soft tissue injuries as noted in Table 1 and Table 2. In order to potentially see a greater difference between these two figures, a larger data set would be needed. Another potential limitation of this study is the retrospective design, which does not allow direct quantification of true effect of recovery sleeve usage on tissue recovery. A third limitation included inability to eliminate confounding variables impacting recovery, including individual athlete preferences for additional recovery interventions, which is commonplace in the professional sports setting. With the bulk of the injury data of this professional soccer team being confidential, a fourth limitation of this study includes limited access to complete injury data.

Results of this study suggest that utilizing non-compressive recovery leg sleeves may reduce the time lost due to soft tissue injury of the lower extremities in soccer athletes. While previous studies have examined effects of compressive garments on muscle recovery (Weakley et al 2022; Cullen et al 2021), further research should be focused on measuring the direct effects of the non-compressive recovery wear on the physiological healing process of tissue at the cellular level, functional outcomes, and to determine other benefits and contraindications that may be present as a result of wearing this garment. This study provides initial findings in support non-compressive garments for use as recovery wear, which is an otherwise minimally researched niche area.

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TABLES

Table 3.— *All Lower Extremity Injuries; No-Sleeve Season vs. Sleeve Season*

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Table 1: () = standard deviation, * = $p < 0.05$

Table 4.— *Lower Extremity Soft Tissue-Only Injuries; No-Sleeve Season vs. Sleeve Season*

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Table 2: ST = soft tissue, () = standard deviation, * = $p < 0.05$

TITLES OF FIGURES

Figure 1.— Time-Loss: Lower Extremity Injuries

Figure 2.— Time-Loss: Lower Extremity Soft Tissue Injuries

SUPPLEMENTARY MATERIAL

Supplementary Material: Recovery Leg Sleeves Protocol