COMPARING ATHLETIC PERFORMANCE, STABILITY AND COMFORT
IN ATHLETES WEARING THE UNDER ARMOUR® BLUR CLEAT IN
DIFFERENT CONDITIONS

by

Sean Stryker

Approved:

_____________________________________________________
Thomas W. Kaminski, Ph.D., ATC, FNATA, FACSM
Professor in charge of thesis on behalf of the Advisory Committee

Approved:

_____________________________________________________
William B. Farquhar, Ph.D.
Chair of the Department of Kinesiology and Applied Physiology

Approved:

_____________________________________________________
Kathleen S. Matt, Ph.D.
Dean of the College of Health Sciences

Approved:

_____________________________________________________
James G. Richards, Ph.D.
Vice Provost for Graduate and Professional Education
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIST OF TABLES</td>
<td>vi</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>vii</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>viii</td>
</tr>
<tr>
<td>Chapter</td>
<td></td>
</tr>
<tr>
<td>1 INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>2 METHODS</td>
<td>4</td>
</tr>
<tr>
<td>2.1 Participants</td>
<td>4</td>
</tr>
<tr>
<td>2.2 Procedures</td>
<td>4</td>
</tr>
<tr>
<td>2.3 Data Analysis</td>
<td>9</td>
</tr>
<tr>
<td>3 RESULTS</td>
<td>10</td>
</tr>
<tr>
<td>3.1 Functional Testing</td>
<td>10</td>
</tr>
<tr>
<td>3.2 Stability Testing</td>
<td>10</td>
</tr>
<tr>
<td>3.3 Comfort Assessment</td>
<td>10</td>
</tr>
<tr>
<td>4 DISCUSSION</td>
<td>11</td>
</tr>
<tr>
<td>5 CONCLUSION</td>
<td>15</td>
</tr>
<tr>
<td>6 TABLES AND FIGURES</td>
<td>16</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>23</td>
</tr>
<tr>
<td>Appendix</td>
<td></td>
</tr>
<tr>
<td>A INFORMED CONSENT FORM</td>
<td>27</td>
</tr>
<tr>
<td>B SPECIFIC AIMS</td>
<td>31</td>
</tr>
<tr>
<td>B.1 Specific Aim 1</td>
<td>31</td>
</tr>
<tr>
<td>B.2 Hypothesis 1</td>
<td>31</td>
</tr>
<tr>
<td>B.3 Specific Aim 2</td>
<td>31</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 1: Descriptive statistics of “Functional Testing” ........................19

Table 2: Descriptive statistics of “Stability Testing” ..............................20

Table 3: Descriptive statistics of “Comfort Assessment”.
Comfort was measured along the 10cm line (100mm); the values reported here are in millimeters. For clarification values closer the 100mm meant more comfort. The support values in the table were measured along the 10cm line (100mm); the values reported here are in millimeters. Values closer to 0 indicate ideal support, where positive (+) values indicate too much support and conversely negative (-) values indicate not enough support. .................................................................22
LIST OF FIGURES

Figure 1: 10-Yard Pass Target .................................................16
Figure 2: 10-Yard Cone Drill ..................................................17
Figure 3: Comfort Questionnaire ..........................................18
Figure 4: Arthrometer IE. Comparison of the mean range of motion in degrees of the ankle for the three conditions (cleat, tape, neoprene sleeve) with * indicating significant differences (cleat: tape, sleeve (P=.001), tape: sleeve (P=.009)). Standard deviation is shown with error bars ........................................21
ABSTRACT

The AIM of this study was to determine if the addition of elastic taping or a neoprene sleeve alters performance, stability, and comfort in soccer players compared to wearing a soccer cleat without any external support. Twenty male club soccer players were recruited and randomly assigned to the 3 conditions. Functional testing and comfort assessment for each condition took place in one testing session, while stability testing was completed during a separate session. The only significant finding was improved inversion/eversion stability in both the elastic tape and neoprene sleeve conditions as compared to the cleated condition. The addition of tape or a neoprene sleeve did not have an adverse effect on performance or comfort during functional and stability testing, and should therefore be considered as a method to decrease ankle injuries in soccer athletes as external supports provide increased stability in inversion/eversion range-of-motion.

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Chapter 1

INTRODUCTION

Soccer is the most played, watched, and revenue generating sport in the world with over 265 million participants worldwide of which 85% are males. (Hennig, 2011) Despite the popularity of the sport, research regarding soccer cleats and their role on performance and injury is lacking. The original footwear used for soccer was a leather work boot that later morphed to include leather studs for improved traction. Over the years, soccer footwear has evolved to include features focused on being tight fitting and lightweight. While these features allow players to compete at a high level, they may also predispose athletes to injuries due to a lack of support at the ankle provided by the cleat. (Hennig, 2011)

A 15-year review of the National Collegiate Athletic Association (NCAA) Injury Surveillance System (ISS) of men’s soccer from 1988-2003 determined ankle sprains comprised 17% of all injuries, with an incidence rate of 3.19 injuries per 1000 athlete-exposure hours. (Agel, Dick, Evans, Marshall, & Putukian, 2007) A similar compilation of youth soccer medical records from 1988-1997 determined ankle sprains were the most frequent injuries accounting for 15% of all injuries. (Elias, 2001) Injury to the ankle ligaments occur at a higher rate than any other injury in soccer causing players to miss 7 days of training on average. (Kofotolis, Kellis, & Vlachopoulos, 2007) The majority of ankle sprains (85%) are to the lateral ligaments
and occur due to a rapid plantar flexion/ inversion of the ankle joint. (Putnam, Bandolin, & Krabak, 2012)

External ankle supports are used by athletes with the intention of preventing ankle sprains. Research regarding external ankle supports has investigated specific mechanisms of support including joint stability and proprioception (kinesthetic awareness). (Dizon & Reyes, 2010; Thacker et al., 1999) Improved joint stability as a result of decreases in ankle joint range-of-motion have been reported by Dizon and colleagues. (Dizon & Reyes, 2010) Additionally ankle supports have improved proprioception by enhancing peroneal reaction time in controlling sudden ankle inversion movements. (Thacker et al., 1999) Decreases in ankle sprain incidence have been widely reported as a function of enhanced joint stability and proprioception. (Dizon & Reyes, 2010; Garrick & Requa, 1973; Mickel et al., 2006; Papadopoulos, Nicolopoulos, Anderson, Curran, & Athanasopoulos, 2005; Simon, 1969; Surve, Schwellnus, Noakes, & Lombard, 1994; Thacker et al., 1999; Tropp, Askling, & Gillquist, 1985) Dizon et al. suggested that the likelihood of additional ankle sprains can be reduced by up to 70% in athletes with previous ankle sprain histories by using external ankle supports. (Dizon & Reyes, 2010) Of great importance are the numerous studies reporting minimal to no effect on athletic performance in those wearing external ankle supports. (Bot & van Mechelen, 1999; Burks, Bean, Marcus, & Barker, 1991; Cordova, Scott, Ingersoll, & LeBlanc, 2005; Gross, Everts, Roberson, Roskin, & Young, 1994; Papadopoulos et al., 2005; Paris, 1992; Putnam et al., 2012) These studies have primarily investigated agility, jumping, and speed in sports such as
football and basketball which are sports where the use of the upper extremity dominates. Research focusing on lower extremity sports such as soccer is limited.(Cordova et al., 2005) However, a recent study by Putnam and colleagues suggests that soccer players have some hesitation in using external supports for fear that they will decrease performance and be uncomfortable.(Putnam et al., 2012)

Determining the effect of external ankle supports on functional performance is an important first step in trying to decrease the incidence of ankle sprains, especially in the sport of soccer; because in order to prevent sprains soccer athletes must first be convinced that external supports are not an impediment to performance. Research suggests that soccer footwear influences sprinting speed, kicking accuracy, and velocity; however additional research investigating injury protection mechanisms is warranted.(Hennig, 2011) Therefore, the purpose of this study was to determine if the addition of an external ankle support (ankle taping or neoprene sleeve) had an effect on performance, stability, and comfort in soccer players wearing the Under Armour® Blur Cleat (Under Armour Inc. Baltimore, MD). We hypothesized there would be no significant difference in functional performance amongst the three conditions, that both the taping and neoprene sleeve would improve stability, and that the cleat alone would be the most comfortable condition rated by the players. Demonstrating that an ankle taping or neoprene sleeve allows for equal performance and comfort as compared to cleats alone, would potentially provide players and clinicians with an ankle injury prevention strategy that could be employed with soccer athletes.
Chapter 2

METHODS

2.1 Participants

A total of 20 male soccer athletes (height: 180.5cm ± 5.3cm, mass: 76.9kg ± 8.0kg) ranging in age from 18-22 years old were recruited from the University of Delaware club soccer team to participate in this study. Subjects were excluded if they had an ankle or knee injury in the previous six months. All participants signed institutionally approved documents of informed consent prior to participation in the study (UD IRB # 395019-1)

2.2 Procedures

The subjects participated in two individual testing sessions, separated by at least 7 days. The first session was completed on a turf field and consisted of functional testing and a cleat comfort assessment. The second session was completed in a laboratory and consisted of stability testing.

A crossover study design was utilized, in that the experimental interventions were administered to the same group of subjects in a random order. The interventions included the Under Armour® Blur Cleat without tape or a neoprene sleeve, Under Armour® Blur Cleat with 2” elastic tape, and Under Armour® Blur Cleat with a neoprene sleeve. The ankle taping procedure used was the “Louisiana wrap” with tape (Convidien Sher-Light™ Elastic Adhesive Tape, Mansfield, MA) instead of cloth.
We chose the “Louisiana Wrap” taping method for several reasons including: (1) it utilized lightweight flexible tape, (2) the continuous manner in which it is applied creates less bulk and, (3) it is simple to apply and recreate. To control for error associated with the application of the taping techniques all taping was applied by the same certified athletic trainer (SS) who is proficient in the technique. The subjects were responsible for securing the cleat properly for all testing conditions. The commercially available neoprene sleeve was secured according to recommended fitting guidelines.

**Functional Testing**

To determine the effect of an ankle taping and neoprene sleeve on performance all subjects underwent four functional tests. The subjects completed each test in all three conditions described above.

**40-yd Dash:** Subjects were asked to sprint as fast as possible across a distance of 40-yards (36.58m) one time. A handheld stopwatch was used to record the amount of time to cover the distance in seconds. The timed 40-yd dash measure has been used in previous research and is a reliable measurement (ICC=.99) of speed in a single trial.(Hetzler, Stickley, Lundquist, & Kimura, 2008; Putnam et al., 2012)

**Vertical Jump:** Subjects were asked to stand in front of the Vertec Jump Measurement Device (Sports Imports, Columbus, OH) on both feet and instructed to jump upward and touch the highest vane on the device. A total of 3 trials were completed with the highest distance jumped in centimeters recorded. The vertical jump task has been
used in previous research as a measurement of power. (Nuzzo, Anning, & Scharfenberg, 2011)

**10-yard Pass Drill:** A target measuring 1.22 X .91m was constructed similar to the one described by Finoff et al. (Figure 1). (Finnoff, Newcomer, & Laskowski, 2002) A white circle (bull’s-eye) was drawn at the bottom center of the target with a diameter of 5cm. Each subject was instructed to kick the soccer ball at the target from a distance of 10 yards (9.14m). They were able to take 5 practice attempts prior to 5 testing attempts. The distance from the center of the bulls-eye to the actual point of contact from the kicked soccer ball was recorded in centimeters with a tape measure after each trial. The average of the 5 trials was recorded and used for data analysis. This method of kicking accuracy was found to be reliable (ICC=.99). (Finnoff et al., 2002)

**10-yard Cone Drill:** Five cones were placed in a straight line 2.28 meters apart spanning a distance of 10 yards (9.14m) (Figure 2). Subjects were instructed to dribble in-and-out of each cone as fast as they could to the last cone and back. Subjects were given one practice trial followed by one test trial. The test trial was timed using a hand-held stopwatch and recorded for data analysis.

**Stability Testing**

To determine the effect of an ankle taping and neoprene sleeve on balance, range-of-motion, and proprioception all subjects underwent three tests. The subjects completed each test in all three conditions described above.
Balance Error Scoring System (BESS): Only 4 of the 6 BESS stances were utilized in this study. They included the double-leg, single-leg (non-dominant), and tandem stance (non-dominant in back) on a firm surface and a double-leg stance on a foam surface. The two most difficult stances (single-leg and tandem) on foam surface were excluded for safety reasons because of the difficulty in performing these test stances in cleats. Each stance was recorded using a video camera and lasted for 20 seconds. Subjects were instructed to remain as motionless as possible with their eyes closed and hands on their hips. Using video playback the total number of errors for each test trial were recorded and used in subsequent data analysis. Errors were recorded using standard BESS protocol. (Bell, Guskiewicz, Clark, & Padua, 2011) The BESS test had been used in previous research to assess static balance and has moderate (ICC<= 0.75) to good (ICC=>0.75) reliability. (Bell et al., 2011)

Ankle Arthrometry: Ankle joint laxity was assessed using an instrumented ankle arthrometer (Blue Bay Research Inc. Nevarre, FL). An anterior/ posterior (AP) translation stress was applied with a force of 130N and measured in mm of displacement. An inversion/ eversion (IE) rotation stress was applied with a torque of 4200Nmm and measured in degrees. Subjects were tested in a manor consistent with those previously reported by Hubbard et al (2003). Both the left and right ankles were tested with a total of 3 AP and 3 IE trials. The 3 AP trials on the left were then combined with the 3 AP trials on the right and then averaged. The same was done for IE on the left and right ankle. This average value was then used for data analysis. The
ankle arthrometer has been found reliable (ICC=.80-.99) for assessing AP translation and IE rotation. (Hubbard, Kovaleski, & Kaminski, 2003)

**Threshold to Detection of Passive Movement (TTDPM):** Proprioception utilizing TTDPM was used to assess this construct involving each of the three test conditions. The subjects were seated and blindfolded on an isokinetic dynamometer with their foot and ankle secured to the footplate while holding a touch switch that they could trigger upon sensing motion. The exact procedures utilized by Kaminski and Gerlach (Kaminski & Gerlach, 2001) were used in this study. Both right and left ankles were tested and the distance moved was calculated in degrees. The degrees moved on the left ankle were then combined with the degrees moved on the right ankle and then averaged. This average score was used for data analysis.

**Comfort Assessment**

To determine the effect of each of the three conditions on comfort and support a subjective self-reported questionnaire (Figure 3) was completed by each subject immediately following functional testing. The subjects were instructed to draw a vertical line on the horizontal scale (10cm line) at a point that best described the response to the question. Comfort was scored from 0 (not comfortable at all) to 100 (most comfortable imaginable); while support was scored from -50 (no support at all) to 50 (too supportive). After careful consideration we decided the center of the 10cm line (theoretical zero) was ideal support. Therefore subjects rating to the left of this theoretical zero point perceived less support and to the right perceived too much support. For comfort assessment an overall average score was created from the four
lines (overall shoe comfort, forefoot cushioning, arch cushioning, heel cushioning). Similarly an overall average support score was created from the two lines (arch support, heel support).

2.3 Data Analysis

An *a priori* power analysis suggested that a sample size of 20 subjects was sufficient to detect significant changes with a medium effect size (.50) at a significance level of alpha = .05. The independent variables evaluated in this study were the Under Armour® Blur Cleat without tape or neoprene sleeve, Under Armour® Blur Cleat with 2” elastic tape, and Under Armour® Blur Cleat with a neoprene sleeve. The dependent variables included the functional tests examined: the 40-yard dash in seconds, vertical jump in centimeters, 10-yard pass drill in centimeters, and 10-yard cone drill in seconds, and the stability measurements including the BESS test errors, AP displacement in millimeters, IE rotation in degrees, and TTDPM in degrees. The comfort dependant variables that were examined include comfort in millimeters, and support in millimeters. Data were analyzed with an alpha level set *a priori* at $P < 0.05$. Within subjects (cross-over) ANOVAs were used to compare the means between the three conditions.
Chapter 3

RESULTS

3.1 Functional Testing

There were no significant differences noted between any of the three conditions involving all 4 functional tests (Table 1).

3.2 Stability Testing

Of the various dependant variables assessed involving stability only inversion/eversion range-of-motion assessed with the ankle arthrometer was significantly different (F=19.9, df=2.0, P=0.001) between the three test conditions. Tukey post-hoc testing was utilized to determine where those significant differences were. As hypothesized IE rotation was greater under the cleat alone condition verse both tape and the neoprene sleeve conditions (Figure 4). In addition, significant differences were noted between the tape and neoprene sleeve (P=0.009), with the neoprene sleeve allowing more motion (Figure 4). The ANOVA’s involving the remaining stability test measures revealed no significant differences between the three testing conditions. The results are summarized in Table 2.

3.3 Comfort Assessment

There were no significant differences noted between any of the three conditions involving self reported comfort and support (Table 3).
Chapter 4

DISCUSSION

This novel study utilized a variety of functional, stability, and comfort measurements to appropriately assess skilled soccer athletes under various conditions of ankle support. The results of this study suggest that the addition of ankle taping or a neoprene sleeve to a cleated foot while improving stability does not have an adverse effect on performance or comfort. Our results indicate that the addition of either ankle taping or a neoprene sleeve significantly improves ankle joint stability as measured by IE ankle arthrometry. Interestingly there were no differences in AP translation, suggesting that the enhanced stability in the direction of the majority of ankle sprains does not hinder necessary talocrural joint motion (plantar flexion/ dorsiflexion).

Numerous previous reports involving external ankle supports have indicated decreases in ankle sprains through an increase in joint stability.(Dizon & Reyes, 2010; Garrick & Requa, 1973; Mickel et al., 2006; Papadopoulos et al., 2005; Simon, 1969; Surve et al., 1994; Thacker et al., 1999; Tropp et al., 1985) Tropp et al. (1985) investigated the effect of a cloth and plastic ankle braces on injury rates of male soccer players in a 6 month season. They determined that of the 60 players who wore the brace only 3% (2) suffered ankle sprains while 17% (30) of the 171 control players did. An additional study by Surve et al.(1994) investigated the effect of an Aircast Sport Stirrup (DJO Global, Inc. Vista, CA) ankle brace on ankle sprain rates in both those
with (n=258) and without (n=246) a previous history of an ankle sprain. They
determined that athletes with a history of an ankle sprain had significantly decreased
incidence rates (injuries/1000 playing hours) while wearing the ankle brace (0.14)
compared to those who did not wear the brace (0.86).

While it has been reported that the addition of an external ankle support
increases proprioception of the ankle joint both in the injured and uninjured population
(Miralles Iris et al., 2010; Spanos, Brunswic, & Billis, 2008), our results suggested
otherwise. Similar to our findings, a review of 8 studies by Raymond et al.
brace or taping had no effect on proprioception. Of the 32 studies they analyzed 19
reported no differences in proprioception, 10 reported improvements in
proprioception, and 3 found decreases in proprioception; there total mean difference
was 0.08° (95% CI: -0.39 to 0.55). The 10 cases reporting improvements in
proprioception involved either an ankle brace or a basketweave ankle taping, while the
3 that found decreases in proprioception used ankle tapings other than the
basketweave technique.(Raymond et al., 2012) The results of our study finding no
significant difference in proprioception between the three conditions could be related
to our technique of the ankle taping (Louisiana wrap) and the use of the commercially
available ankle neoprene sleeve. We contend that these support conditions while in
contact with the skin did not significantly improve proprioception (enhance cutaneous
receptors) any more than the cleat alone condition.
Soccer players are hesitant to use an external ankle support due to the perception they decrease performance and comfort. (Putnam et al., 2012) As we hypothesized no significant differences were noted for sprint speed, vertical jump, kicking accuracy, and dribbling through cones. Our findings regarding minimal to no differences for speed, power, kicking accuracy, and agility are similar to those of previous studies. (Bot & van Mechelen, 1999; Burks et al., 1991; Cordova et al., 2005; Gross et al., 1994; Papadopoulos et al., 2005; Paris, 1992; Putnam et al., 2012) Putnam et al. (2012) studied the impact of ankle bracing on performance in 20 recreational soccer players without a history of a lower extremity injury in the last 6 months. All subjects completed accuracy shooting at a target, 40-yard dash, S180° run, and a T-test in two testing sessions. During each session the subjects completed all 4 tests with and without a McDavid 199 Lightweight ankle brace (McDavid, Woodridge, IL). They reported no significant differences in the 4 tests within a session or between testing sessions. These findings directly relate to the outcomes of the functional tests in our study. A similar study was completed by Paris et al. (1992) looking at the effect of ankle bracing on speed, balance, agility, and vertical jump height. Similar to our results they reported no significant differences between braced and non-braced subjects.

A recent survey completed by Hennig (Hennig, 2011) reported the most important features of a cleat according to soccer players are comfort and stability. Our findings found no significant differences between the 3 conditions for self-reported comfort or support. Intuitively there appears to be a balance between comfort and
stability in creating the “ideal”. Although we hypothesized the cleat condition alone would be most comfortable we were pleasantly surprised to find the athletes rated comfort and support equally across all three test conditions. Perhaps unfounded perceptions regarding the use of ankle taping and/or neoprene supports can be lessened by educating soccer athletes to the benefits they provide.

Although our study was limited to utilizing club level soccer players with varied skill levels none however demonstrated any difficulty in performing the various functional tasks. We suggest an interesting comparison to our study using elite level soccer players may be worthy. Of note regarding our ankle arthrometry measurements is the fact that they were only performed during stability testing in a laboratory setting. Perhaps it would have been interesting to see if differences existed between the three conditions immediately following functional testing.
Chapter 5

CONCLUSION

Ankle sprains occur at a higher rate than any other injury in soccer players. External ankle supports have been proven to decrease the incidence of ankle sprains however, soccer players are hesitant to use them because of the perception they decrease performance and are uncomfortable. Our study of healthy male club soccer players determined that the addition of either tape or a neoprene sleeve did not have an adverse effect on speed, power, kicking accuracy, agility, static balance, or proprioception. The addition of tape or a neoprene sleeve did not have an adverse effect on performance or comfort during functional and stability testing, and should therefore be considered as a method to decrease ankle injuries in soccer athletes as external supports provide increased stability in inversion/eversion range of motion.
Chapter 6

TABLES AND FIGURES

Figure 1: 10-Yard Pass Target
Figure 2: 10-Yard Cone Drill
**Figure 3:** Comfort Questionnaire

With regard to your shoe, please rate the following by placing a single vertical line on the scale.

1. With regard to COMFORT:

<table>
<thead>
<tr>
<th>Overall shoe comfort</th>
<th>not comfortable at all</th>
<th>most comfortable imaginable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forefoot cushioning</td>
<td>not comfortable at all</td>
<td>most comfortable imaginable</td>
</tr>
<tr>
<td>Arch cushioning</td>
<td>not comfortable at all</td>
<td>most comfortable imaginable</td>
</tr>
<tr>
<td>Heel cushioning</td>
<td>not comfortable at all</td>
<td>most comfortable imaginable</td>
</tr>
</tbody>
</table>

2. With regard to AMOUNT OF SUPPORT

<table>
<thead>
<tr>
<th>Arch support</th>
<th>no support at all</th>
<th>too supportive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heel support</td>
<td>no support at all</td>
<td>too supportive</td>
</tr>
</tbody>
</table>
Table 1: Descriptive statistics of “Functional Testing”

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Range</th>
<th>P-Value</th>
<th>F-Value</th>
<th>95% CI for Mean</th>
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<tbody>
<tr>
<td><strong>40-Yard Dash (sec)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cleat</td>
<td>5.07 ± .24</td>
<td>4.65-5.78</td>
<td>.29</td>
<td>1.34</td>
<td>4.96-5.18</td>
</tr>
<tr>
<td>Tape</td>
<td>5.02 ± .30</td>
<td>4.53-5.68</td>
<td></td>
<td></td>
<td>4.88-5.16</td>
</tr>
<tr>
<td>Sleeve</td>
<td>5.03 ± .31</td>
<td>4.50-5.75</td>
<td></td>
<td></td>
<td>4.88-5.17</td>
</tr>
<tr>
<td><strong>Vertical Jump (cm)</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Cleat</td>
<td>66.17 ± 7.97</td>
<td>50.80-81.28</td>
<td>.15</td>
<td>2.15</td>
<td>62.44-69.90</td>
</tr>
<tr>
<td>Tape</td>
<td>64.39 ± 7.99</td>
<td>45.72-83.82</td>
<td></td>
<td></td>
<td>60.65-68.13</td>
</tr>
<tr>
<td>Sleeve</td>
<td>66.04 ± 7.23</td>
<td>49.53-81.28</td>
<td></td>
<td></td>
<td>62.66-69.42</td>
</tr>
<tr>
<td><strong>10-Yard Pass (cm)</strong></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleat</td>
<td>30.19 ± 9.99</td>
<td>11.68-51.05</td>
<td>.88</td>
<td>.14</td>
<td>25.51-34.87</td>
</tr>
<tr>
<td>Tape</td>
<td>29.91 ± 8.40</td>
<td>10.16-46.23</td>
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<td></td>
<td>25.97-33.84</td>
</tr>
<tr>
<td>Sleeve</td>
<td>30.80 ± 7.47</td>
<td>20.82-46.74</td>
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<td>27.30-34.29</td>
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<tr>
<td><strong>10-Yard Cone Drill (sec)</strong></td>
<td></td>
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<tr>
<td>Cleat</td>
<td>09.94 ± 1.07</td>
<td>8.05-12.43</td>
<td>.39</td>
<td>.99</td>
<td>9.44-10.44</td>
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<tr>
<td>Tape</td>
<td>10.22 ± 1.13</td>
<td>8.56-12.84</td>
<td></td>
<td></td>
<td>9.69-10.75</td>
</tr>
<tr>
<td>Sleeve</td>
<td>09.94 ± 1.00</td>
<td>8.25-12.32</td>
<td></td>
<td></td>
<td>9.47-10.41</td>
</tr>
</tbody>
</table>
Table 2: Descriptive statistics of “Stability Testing”

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Range</th>
<th>P-Value</th>
<th>F-Value</th>
<th>95% CI for Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BESS Test (Errors)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleat</td>
<td>2.25 ± 2.10</td>
<td>0-7</td>
<td>.31</td>
<td>1.27</td>
<td>1.27-3.23</td>
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<tr>
<td>Tape</td>
<td>2.90 ± 2.08</td>
<td>0-7</td>
<td></td>
<td></td>
<td>1.93-3.87</td>
</tr>
<tr>
<td>Sleeve</td>
<td>2.20 ± 2.65</td>
<td>0-11</td>
<td></td>
<td></td>
<td>0.96-3.44</td>
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<tr>
<td><strong>AP Arthrometer(mm)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleat</td>
<td>7.20 ± 1.73</td>
<td>3.12-11.41</td>
<td>.06</td>
<td>3.43</td>
<td>6.39-8.01</td>
</tr>
<tr>
<td>Tape</td>
<td>6.65 ± 1.75</td>
<td>2.73-10.31</td>
<td></td>
<td></td>
<td>5.83-7.47</td>
</tr>
<tr>
<td>Sleeve</td>
<td>7.12 ± 1.63</td>
<td>2.85-10.09</td>
<td></td>
<td></td>
<td>6.36-7.88</td>
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<tr>
<td><strong>TTDPM (deg)</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cleat</td>
<td>1.54 ± .28</td>
<td>1.07-2.00</td>
<td>.41</td>
<td>.93</td>
<td>1.41-1.67</td>
</tr>
<tr>
<td>Tape</td>
<td>1.54 ± .29</td>
<td>1.88-2.12</td>
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<td></td>
<td>1.41-1.67</td>
</tr>
<tr>
<td>Sleeve</td>
<td>1.49 ± .25</td>
<td>1.17-1.98</td>
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<td></td>
<td>1.38-1.61</td>
</tr>
</tbody>
</table>
Figure 4: Arthrometer IE. Comparison of the mean range of motion in degrees of the ankle for the three conditions (cleat, tape, neoprene sleeve) with * indicating significant differences (cleat: tape, sleeve (P=.001), tape: sleeve (P=.009)). Standard deviation is shown with error bars.
Table 3: Descriptive statistics of “Comfort Assessment”. Comfort was measured along the 10cm line (100mm); the values reported here are in millimeters. For clarification values closer the 100mm meant more comfort. The support values in the table were measured along the 10cm line (100mm); the values reported here are in millimeters. Values closer to 0 indicate ideal support, where positive (+) values indicate too much support and conversely negative (-) values indicate not enough support.

<table>
<thead>
<tr>
<th></th>
<th>Mean ± SD</th>
<th>Range</th>
<th>P-Value</th>
<th>F-Value</th>
<th>95% CI for Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comfort (mm)</strong></td>
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<tr>
<td>Cleat</td>
<td>60.59 ± 18.83</td>
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<td>.32</td>
<td>1.20</td>
<td>51.78-69.40</td>
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<tr>
<td>Tape</td>
<td>65.91 ± 15.56</td>
<td>39.50-98.25</td>
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<td>Sleeve</td>
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<td>25.25-86.50</td>
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<td><strong>Support</strong></td>
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<td></td>
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<td>Cleat</td>
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<td>.06</td>
<td>3.26</td>
<td>-7.42-9.42</td>
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<tr>
<td>Tape</td>
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<tr>
<td>Sleeve</td>
<td>11.88 ± 17.71</td>
<td>-22.5-47.5</td>
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<td>3.59-20.16</td>
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</table>
REFERENCES


Appendix A

INFORMED CONSENT FORM


Principal Investigator (s): Sean Stryker, ATC, Thomas W. Kaminski, PhD (professor) in the Department of Kinesiology and Applied Physiology

Other Investigators: Andrea Di Trani, MS, STC, Shannon Riley, and Recreation Services

You are being asked to participate in a research study. This form tells you about the study including its purpose, what you will do if you decide to participate, and any risks and benefits of being in the study. Please read the information below and ask the research team questions about anything you do not understand before you decide whether to participate or not. Your participation is voluntary and you can refuse to participate or withdraw at any time without penalty or loss of benefits to which you are otherwise entitled. If you decide to participate, you will be asked to sign this form and a copy will be given to you to keep for your reference.

WHAT IS THE PURPOSE OF THIS STUDY?
The purpose of this study is to compare your performance in a variety of athletic skills while wearing different cleats and under different conditions. You are being asked to take part in this study because you are a student-athlete on the UD Club soccer team.

WHAT WILL YOU BE ASKED TO DO?
You are one of 20 athletes volunteering to participate in this study during your offseason. Student-athletes with any injury at the time of (or during) the study will be excluded from participating. You will be asked to arrive for testing wearing running shoes and shorts. Testing venues will include the Athletic Training Research Lab, Human Performance Lab, Bob Carpenter Center Athletic Training Room, Delaware Field House Athletic Training Room, and the intercollegiate athletics turf practice fields. Two hours of testing will be required on two separate occasions. To begin your age, height, and weight will be recorded.

Cleat Type and Tape/Brace Conditions:
You will be randomly assigned to all three treatment conditions. Testing will take place on two separate days. One day will be functional testing and the other will be lab testing.

a) **Condition I** – UA Blur Cleat – you will be given the appropriate size cleat and instructed to lace it up according to the manufacturer’s directions.

b) **Condition II** – UA Blur Cleat + Tape – A certified athletic trainer will execute a standard ankle taping on both ankles before securing the cleats in place. In addition, you will be given the appropriate size cleat and instructed to lace it up according to the manufacturer’s directions.

c) **Condition III** - UA Blur Cleat + Neoprene Sleeve - You will be provided with a commercially available neoprene sleeve that will be worn under your socks before securing the cleat into place. In addition, you will be given the appropriate size cleat and instructed to lace it up according to the manufacturer’s directions.

Upon completing the above treatment conditions, testing will begin.

**Human Performance Lab Testing:**
In the Human Performance Lab we will assess the following:

1) **Proprioception** using Threshold to Detection of Passive Movement (TTDPM) measures

   For this test you will sit in the chair of a device that will slowly move your foot/ankle. You will be blindfolded during the test to eliminate visual cues. Upon detecting the first hint of motion you will hit the “kill switch” button of the device and the motion will stop. We will test both legs three (3) times under each of the cleat conditions outlined above.

2) **Balance** using the Balance Error Scoring System (BESS)

   We will assess your balance while standing quietly on either a firm (floor) or foam surface using the three stances shown above. For floor testing you will stand on an anti-slip mat. You are to remain as motionless as possible during each test trial. Each trial is timed for 20 seconds. You will perform three trials of each while wearing the cleats.

3) **Ankle Stability/Laxity** utilizing an Instrumented Ankle Arthrometer

   We will assess the laxity of your ankle joint while wearing the cleat with the device shown above strapped to your foot/ankle. Both ankles will be measured.

   Upon completing the testing in the Human Performance Lab we will walk out to the practice athletic fields for the remaining performance tasks.

**Athletic Field Testing:**
Each of the following performance tasks may be familiar to you as they are commonly used in strength and conditioning workouts. We ask that you provide maximal effort during each task. You will be wearing the assigned cleat condition during the
execution of each test. A brief warm-up consisting of stretching and jogging activities will be provided before testing begins. All tests will be assessed in a random order.

1) **40-yr Dash performance**
This is a timed test assessing your speed over a 40 yard distance. One trial will be performed. A retest will be implemented if you stumble or fall during the test.

2) **Vertical Jump**
Using the Vertec device as shown above we will measure your vertical jump distance. A total of three (3) trials will be conducted.

3) **10-yr Pass Drill**
This is a passing accuracy test. You will have 5 attempts to kick the soccer ball at the target and the distance you miss by will be recorded. Five practice attempts will be provided before testing begins.

4) **10-yr Cone Drill**
This is a timed test to assess your speed while dribbling the ball (with both feet) in and out of cones. One practice and one test trial will be performed.

At the conclusion of the testing you will be asked to complete a brief questionnaire to rate the cleat comfort. In addition, you will be provided a few minutes of cool-down to stretch and or jog; after which the testing is finished.

**WHAT ARE THE POTENTIAL BENEFITS?**
You will not benefit directly from taking part in this research. However the knowledge gained from this study may influence how you choose a cleat for participating in future sporting competitions.

**WHAT ARE THE RISKS OF THE STUDY?**
The risks associated with the study are minimal. You may develop muscle soreness in the lower extremity 24 - 48 hours following testing and training.

**HOW WILL CONFIDENTIALITY BE MAINTAINED?**
Data will be kept confidential and your information will be assigned a code number. The list connecting your name to this number will be kept in a locked file. When the study is completed and the data have been analyzed, the list will be destroyed. Data will be kept securely in electronic storage formats and saved indefinitely. Your name will not be used in any report. We will make every effort to keep all research records that identify you confidential to the extent permitted by law. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared. Your research records may be viewed by the University of Delaware Institutional Review Board, but the confidentiality of your records will be protected to the extent permitted by law.

**WILL THERE BE ANY COSTS RELATED TO THE RESEARCH?**
There are NO costs associated with your participation.

**WILL THERE BE ANY COMPENSATION FOR PARTICIPATION?**
Club Soccer will receive a donation for allowing the team to participate in this study.

WHAT IF YOU ARE INJURED BECAUSE OF THE STUDY?
If you are injured during research procedures, you will be offered first aid at no cost. If you require additional medical treatment, you will be responsible for the cost.

DO YOU HAVE TO TAKE PART IN THIS STUDY?
Taking part in this research study is entirely voluntary. You do not have to participate in this research. If you choose to take part, you have the right to stop at any time. If you decide not to participate or if you decide to stop taking part in the research at a later date, there will be no penalty or loss of benefits to which you are otherwise entitled. Your refusal will not influence current or future relationships with the University of Delaware. As a student, if you decide not to take part in this research, your choice will have no effect on your academic status or your grade in the class.

WHO SHOULD YOU CALL IF YOU HAVE QUESTIONS OR CONCERNS?
If you have any questions about this study, please contact the Principal Investigators: Sean M. Stryker at 973-945-7565 or stryker@udel.edu; Dr. Thomas W. Kaminski at 302-831-6402 or kaminski@udel.edu
If you have any questions or concerns about your rights as a research participant, you may contact the University of Delaware Institutional Review Board at 302-831-2137.

Your signature below indicates that you are agreeing to take part in this research study. You have been informed about the study’s purpose, procedures, possible risks and benefits. You have been given the opportunity to ask questions about the research and those questions have been answered. You will be given a copy of this consent form to keep.
By signing this consent form, you indicate that you voluntarily agree to participate in this study.

_________________________________                               ______________
Signature of Participant                                                            Date

________________________________
Printed Name of Participant

________________________________
Principal Investigator

______________________________
Date
Appendix B

SPECIFIC AIMS

B.1 Specific Aim 1 To determine the comfort of the soccer cleat in the three different conditions (cleat alone, cleat with tape, and cleat with a neoprene sleeve) using a subjective questionnaire.

B.2 Hypothesis 1 It is hypothesized that the cleat alone will be the most comfortable since it is what soccer players are most familiar with wearing. It is believed that the addition of external ankle support will decrease the self-reported comfort scores.

B.3 Specific Aim 2 To determine the effect of the three conditions (cleat alone, cleat with tape, and cleat with a neoprene sleeve) on functional performance.

B.4 Hypothesis 2 Despite the added stability provided by the external supports it is hypothesized there will be no significant difference in functional performance.

B.5 Specific Aim 3 To determine the effect of the three conditions (cleat alone, cleat with tape, and cleat with a neoprene sleeve) on stability, range-of-motion and proprioception.

B.6 Hypothesis 3 It is hypothesized that the conditions involving the tape and neoprene sleeve will result in improvement in the measures of stability.
Appendix C

BACKGROUND AND SIGNIFICANCE

C.1 Soccer Cleats and Injury

Soccer is the most played, watched, and revenue generating sport in the world. (Hennig, 2011) In 2006 it was determined by the Fédération Internationale de Football Association (FIFA) that 4% (265 million) of the world population were active soccer players. Soccer is predominately played by males, which account for 85% of total active players. Despite the widespread popularity of soccer across the world, there are areas of research that are severely lacking in the literature. One of these areas includes the study of soccer cleats and how they affect performance and injury. (Hennig, 2011)

The original footwear used for soccer was termed a “boot”. English factory workers used a leather work boot and later added leather studs to the bottom for improved traction. The boots were deemed to be non-ideal due to their heavy weight and restriction of motion. In 1960 low-top cleats were introduced to allow more motion at the ankle joint. Since then, the soccer cleat design has continued to evolve with today’s properties focusing on being tight fit and lightweight. While these components allow players to compete at a high level, they also predispose soccer players to injuries due to a lack of ankle support provided by the cleat. (Hennig, 2011)
A 15 year review of the National Collegiate Athletic Association (NCAA) Injury Surveillance System (ISS) from 1988-2003 revealed that ankle ligament sprains are the most prevalent injury in men’s soccer. Ankle ligament sprains comprised 17% of all injuries, with an incidence rate of 3.19 injuries per 1000 athlete-exposures.(Agel et al., 2007) A similar compilation of injury records was completed for youth soccer players between 1988-1997 and determined that ankle sprains were the most prevalent injury, accounting for 15% of all injuries.(Elias, 2001) Ankle sprains are the most prevalent injury in soccer and research is needed to determine how to decrease their incidence.

C.2 External Ankle Supports and Effect on Injury

Research focused on reducing the incidence of ankle sprain injury is important to scholars, clinicians, and soccer players. Ankle sprains on average cause players to miss 7 days of training.(Kofotolis et al., 2007) Researchers have investigated multiple preventative interventions including taping techniques and ankle braces, both of which are commonly used by athletes.(Dizon & Reyes, 2010; Papadopoulos et al., 2005) Both taping and bracing have been proven to decrease the incidence of ankle sprains in an athletic population, by improving stability and proprioception at the ankle joint.(Dizon & Reyes, 2010; Garrick & Requa, 1973; Mickel et al., 2006; Thacker et al., 1999)

Mickel et al.(Mickel et al., 2006) completed a study comparing the effectiveness of ankle taping and prophylactic bracing in high school football players. Ninety-three subjects were divided into ankle taping (45 subjects) and prophylactic
bracing (48 subjects) groups over the course of one season. During the season, three ankle sprains occurred in both the ankle taping and prophylactic bracing groups. It was determined there is no significant difference between ankle taping and prophylactic bracing in the prevention of ankle sprains. (Mickel et al., 2006) Taping will be used for this study as it is hypothesized soccer players would be more likely to be taped rather than wear a brace since it is not as bulky and will not interfere with the tight fit of a soccer cleat.

Garrick and Requa (Garrick & Requa, 1973), studied the effect of ankle taping on the prevention of ankle sprains in collegiate, intramural, basketball players. The study took place over two years and included subjects with no history, occasional history, and frequent history of ankle sprains. The subjects were split into three groups: athletic tape, Jflex (elastic tape), and untaped with no standardization of footwear implemented. It was concluded that both the athletic tape and Jflex (elastic tape) decreased the incidence of ankle sprains. The occurrence rate of high-top shoes and tape was 6.5 sprains per 1000 exposures, high-top and Jflex was 10.8 sprains per 1000 exposures, and high-top alone was 30.4 sprains per 1000 exposures. The occurrence rate of low-top shoes and tape was 17.6 sprains per 1000 exposures, low-top and Jflex was 5.1 sprains per 1000 exposures, and low-top alone was 33.4 sprains per 1000 exposures. The Jflex tape in a low-top shoe was the most effective condition in preventing ankle sprains. (Garrick & Requa, 1973) This study is particularly important in choosing the best option to decrease ankle sprains in soccer players. Soccer cleats are typically low-top and therefore the addition of an elastic tape (Sher-
Light) will be investigated to determine if it is warranted in the prevention of ankle injuries.

Abian-Vicen et al. (Abián-Vicén, Alegre, Fernández-Rodríguez, & Aguado, 2009) compared the mechanical fatigue and subject rated comfort of elastic tape and inelastic tape. All subjects were tested with elastic tape, inelastic tape, and no tape before and after 30 minutes of intense exercise. Prior to the intense exercise, there were no significant differences noted between the elastic and inelastic tape groups in ankle range-of-motion restriction. The inelastic tape group showed significantly (p<0.05) less range-of-motion restriction in inversion than the elastic tape group after 30 minutes of intense exercise. The subjects rated the elastic tape higher for comfort and less restriction. It was concluded that elastic tape should be used as the first choice when applying a prophylactic ankle taping for athletic activity. (Abián-Vicén et al., 2009)

There are several ways to apply an ankle taping or wrapping. Simon et al. (Simon, 1969) compared the “Louisiana wrap” (cloth) to a prototypical ankle taping (double stirrups, double figure-eights, and heel locks) over two spring seasons in collegiate football. The subjects were split evenly into two groups and received the same condition for all spring practices for one season. The following season they received the opposite condition. Over the two seasons, there were 4 ankle sprains in each condition, and therefore there is no difference between the conditions in preventing ankle sprains. (Simon, 1969) The “Louisiana wrap” with elastic tape (Sher-Light) rather than cloth will be used for this study.
C.3 Effect of External Ankle Supports on Performance and Stability

The efficacy of the external support in decreasing injury is important; however this needs to be accomplished without an adverse effect on performance. (Cordova et al., 2005) Athletes will avoid external ankle supports that are perceived to decrease performance. (Bomar, Cordova, Demchak, & Storsved, 2004) A review of the literature by Papadopoulos et al. (Papadopoulos et al., 2005) determined that there is inconclusive evidence on the use of external ankle supports in the performance of jumping, agility, and speed.

Cordova et al. (Cordova et al., 2005) meta-analyzed 17 randomized controlled trials with 93 total effects. The external ankle supports studied included adhesive tape, lace-up brace, and a semirigid brace. Sprint speed, vertical jump, and agility were the performance variables analyzed with 90% confidence intervals. The only significant finding was a negative effect on sprint speed with a lace-up brace. All other performance variables were considered to be unaffected. (Cordova et al., 2005) Sprinting, jumping and agility are all components of a soccer player’s skill set. A decrease in any of these areas could lead to external ankle supports not being well received by soccer players.

The effect of an ankle brace on shooting accuracy, 40-yard dash, S180° run, and T test in recreational soccer players was investigated by Putnam et al. (Putnam et al., 2012) The subjects completed all of the performance measures with an ankle brace (test) and without an ankle brace (control) during two sessions separated by 7-10 days. There were no significant differences found for any of the tests during a session.
or between sessions. (Putnam et al., 2012) This study will look at passing, dribbling, 40-yard dash, and vertical jump of the soccer athletes to determine if performance is hindered by ankle taping or neoprene sleeve.

External ankle supports decrease the range-of-motion at the ankle with the aim of preventing ankle sprains. Ankle sprains are typically caused by a rapid plantar flexion-inversion motion of the ankle, stressing the lateral ligaments. Cordova et al. (Cordova, Ingersoll, & LeBlanc, 2000) completed a meta-analysis of 19 studies with a total of 253 cases looking at ankle taping, a lace-up brace, and a semi-rigid brace. When investigating inversion and eversion, all three conditions were analyzed (ankle taping, lace-up brace, semi-rigid brace). It was determined that prior to exercise and after exercise, a semi-rigid brace provides the greatest restriction to inversion and eversion motion. For dorsiflexion and plantar flexion, only tape and the lace-up brace were analyzed. The tape condition provided the greatest restriction to dorsiflexion both before and after exercise, and there were no significant differences found for plantar flexion. (Cordova et al., 2000) Based on the dynamic nature of the sport, adverse effects on performance should not result from the addition of external support to the ankle joint in soccer players. Soccer cleats are designed to allow full, unrestricted range-of-motion about the ankle joint with the goal of the players performing at a high-level. Braces have been proven to decrease the motion of the ankle more than tape and therefore tape may be the better option for soccer.

Adhesive athletic tape loses its ability to mechanically prevent the ankle from going into plantar flexion inversion after as little as 10 minutes of exercise; however it
has still been shown to decrease the incidence of ankle sprains. The lasting component of ankle taping is its ability to increase the proprioception of the peroneal muscles, therefore preventing inversion of the ankle. (Thacker et al., 1999) Another study by Miralles et al.(Miralles Iris et al., 2010) evaluated joint reposition sense (JRS) of dorsiflexion and plantar flexion in healthy subjects with an ankle taping (intervention group) and no ankle taping (control group). Improved proprioception was noted for the intervention group in both directions with a significant difference found in dorsiflexion JRS. It is thought that an increase in the firing of cutaneous receptors is caused by the ankle taping and therefore allows better joint position sense.(Miralles Iris et al., 2010)

A neoprene sleeve will be used; as it is hypothesized it will be perceived in a similar way to an ankle taping. While research regarding the neoprene sleeve is lacking for the ankle joint it has been proven to increase proprioception at the knee and shoulder.(Lephart & Fu, 1995; Ulkar, Kunduracioqlu, Cetin, & Güner, 2004) Determining if it has any affect on performance, comfort, or stability of the ankle joint could provide an additional option in the prevention on ankle sprains in soccer.

Soccer players rely on footwear being comfortable and allowing them to play at their highest level. Ankle taping has been proven to decrease injury without restricting range-of-motion while increasing proprioception. Determining if soccer players are comfortable with the addition of an ankle taping or neoprene sleeve and are able to achieve desired performance levels, without experiencing any deficits in stability could result in a decrease in the incidence of ankle sprain injuries.
Appendix D

IRB APPROVAL

DATE: November 19, 2012

TO: Thomas Kaminski
FROM: University of Delaware IRB

STUDY TITLE: [395019-1] Comparing Athletic Performance Variables in Athletes Wearing the Under Armour® Highlight Cleat

SUBMISSION TYPE: New Project

ACTION: APPROVED
APPROVAL DATE: November 19, 2012
EXPIRATION DATE: November 18, 2013
REVIEW TYPE: Expedited Review

REVIEW CATEGORY: Expedited review category # 4

Thank you for your submission of New Project materials for this research study. The University of Delaware IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on the applicable federal regulation.

Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. Federal regulations require each participant receive a copy of the signed consent document.

Please note that any revision to previously approved materials must be approved by this office prior to initiation. Please use the appropriate revision forms for this procedure.

All SERIOUS and UNEXPECTED adverse events must be reported to this office. Please use the appropriate adverse event forms for this procedure. All sponsor reporting requirements should also be followed.

Please report all NON-COMPLIANCE issues or COMPLAINTS regarding this study to this office.

Please note that all research records must be retained for a minimum of three years.

Based on the risks, this project requires Continuing Review by this office on an annual basis. Please use the appropriate renewal forms for this procedure.