

5-2017

# The Effect of Floss Bands on Elbow Range of Motion in Tennis Players

Kenna Hodeaux

*University of Arkansas, Fayetteville*

Follow this and additional works at: <http://scholarworks.uark.edu/etd>



Part of the [Physical Therapy Commons](#), and the [Sports Management Commons](#)

---

## Recommended Citation

Hodeaux, Kenna, "The Effect of Floss Bands on Elbow Range of Motion in Tennis Players" (2017). *Theses and Dissertations*. 1948.  
<http://scholarworks.uark.edu/etd/1948>

This Thesis is brought to you for free and open access by ScholarWorks@UARK. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of ScholarWorks@UARK. For more information, please contact [scholar@uark.edu](mailto:scholar@uark.edu), [ccmiddle@uark.edu](mailto:ccmiddle@uark.edu).

The Effect of Floss Bands on Elbow Range of Motion in Tennis Players

A thesis submitted in partial fulfillment  
of the requirements for the degree of  
Master of Education in Recreation and Sport Management

by

Kenna Hodeaux  
Texas Christian University  
Bachelor of Science in Athletic Training, 2015

May 2017  
University of Arkansas

This thesis is approved for recommendation to the Graduate Council.

---

Dr. Steve Dittmore  
Thesis Director

---

Dr. Brendon McDermott  
Committee Member

---

Dr. Terry Eddy  
Committee Member

## **Abstract**

Floss bands have been used to improve ROM, restore joint mechanics, and break down adhesive tissue from previously injured musculature, however, there is limited research available and the few research studies have mixed results on the usefulness of floss bands. The purpose of this study was to investigate the effectiveness of floss bands in increasing elbow range of motion (ROM) in tennis players. Twelve elite tennis players (6 female and 6 male) participated in this randomized crossover design study. Subjects attended two separate sessions. Passive ROM measures were taken with a standard goniometer for elbow flexion and extension and forearm pronation and supination. For each session baseline ROM was initially taken. Subjects went into a separate room to have the intervention applied (floss band or no band) to ensure the author was blind to eliminate bias. After the intervention was applied ROM was re-measured. On their second visit, participants received the intervention that was not previously applied. A paired sample t-test revealed no significant difference ( $p > 0.05$ ) between floss band and no band for all measures. This study is the first to investigate the use of floss bands to improve elbow ROM in elite level tennis players. The results show that floss bands do not significantly improve elbow ROM compared to other treatment methods.

## **Acknowledgments**

Special thanks to Christopher Blaszkla for all of his help with this thesis. It would have been impossible to complete this study without his help.

Also, a special thanks to the thesis committee for their advice and guidance.

## **Table of Contents**

|  |           |
|--|-----------|
| <b>I. Introduction .....</b>                 | <b>1</b>  |
| <b>II. Background .....</b>                  | <b>3</b>  |
| <b>III. Methods .....</b>                    | <b>6</b>  |
| A. Design .....                              | 6         |
| B. Participants.....                         | 6         |
| C. Measures and Instrumentation .....        | 6         |
| D. Procedures.....                           | 7         |
| E. Data Analysis .....                       | 10        |
| <b>IV. Results.....</b>                      | <b>10</b> |
| <b>V. Discussion.....</b>                    | <b>14</b> |
| <b>VI. Conclusion .....</b>                  | <b>16</b> |
| <b>VII. References .....</b>                 | <b>17</b> |
| <b>VIII. Appendices .....</b>                | <b>19</b> |
| A. Consent Form.....                         | 19        |
| B. Research Compliance Protocol Letter ..... | 22        |

## I. Introduction

The use of Voodoo Floss Bands, or simply floss bands, in sport has become increasingly popular because it incorporates movement through a particular range of motion (ROM) in conjunction with therapy. Originating in crossfit gyms and made popular by the book *Becoming A Supple Leopard* (Starrett & Cordoza, 2013), floss bands are used to improve ROM, restore joint mechanics, and break down adhesive tissue from previously injured musculature. The two-inch wide latex rubber band is wrapped around a joint which provides compression while the patient performs movement through the full ROM for one to three minutes. However, there are few research articles to support the use of and mechanisms behind the effectiveness of floss bands.

Current literature of the effects of floss bands is limited to a few studies (Bohlen et al., 2014; Driller & Overmayer, 2017; Plocker, Wahlquist, & Dittrich, 2015). Bohlen et al. (2014) investigated the effects of 14 days of band flossing combined with joint mobilization and resistive exercise on calf blood flow and plantar/dorsiflexion strength in five participants. Floss bands were applied to the experimental leg over the knee while the participants performed unloaded squats, heel raises, active dorsiflexion, and passive ankle mobilization once a day. Blood flow was measured with venous occlusion plethysmography and strength was measured using an isokinetic dynamometer. The authors found that with the use of floss bands, dorsiflexion peak torque was increased by 22% and vascular function and strength were not affected in the experimental leg (Bohlen et al., 2014). Driller & Overmayer (2017) evaluated the effect of floss bands on ankle ROM and jump performance in 52 recreational athletes. Participants performed a weight bearing lunge test, plantar/dorsiflexion ROM, and a single leg vertical jump test before and after the band was applied. The floss band was applied to one ankle,

while the other ankle acted as control, and the subjects performed 20 repetitions of plantar and dorsiflexion simultaneously. The authors found significant improvement in all ROM measures as well as single-leg jump performance after the use of a floss band. However, these results may be skewed due to the low confidence interval (CI±90%). Contrary to these findings, Plocker et al. (2015) examined the effectiveness of tissue flossing on increasing upper extremity power and ROM in 17 male athletes. Subjects attended two sessions, one with the floss band and one without the floss band. During the treatment session, researchers wrapped both shoulders with the floss bands using guidelines from the manufacture and led the subjects through shoulder prehabilitation exercises. Once the band was removed, ROM was measured using a goniometer and upper extremity power was measured using a 3D accelerometer during a bench press. Although Plocker et al. (2015) saw a mean increase in internal and external shoulder ROM, there was not a significant increase in ROM or upper extremity power. These results may be influenced by the fact that the suggested wrapping technique did not efficiently cover all the muscle groups in the shoulder.

There is a large consumer appeal for using floss bands, however, there is limited evidence of its true effects. Although patients have seen notable improvements after treatment using protocols and standards from various blogs and company websites, no medical journals or practices have any set protocols on tension of the band, wrapping techniques, or movement programs to dictate the proper use of floss bands. The lack of protocols can lead to inaccurate results and varied effects. The scarcity of evidence on floss bands warrants further investigation. Users claim one of the main benefits from using floss bands is an increase in ROM. However, a study investigating the effectiveness of floss bands on elbow ROM has yet to be done. Therefore,

the purpose of this study is to investigate the effectiveness of floss bands in increasing elbow ROM in tennis players.

## **II. Background**

As overhead athletes, tennis players are highly susceptible to elbow injuries due to the large forces at the elbow joint (Eygendaal, Rahussen, & Diercks, 2007). Tennis players use a combination of valgus forces and rapid extension which result in tensile forces along the medial aspect, compression on the lateral portion, and shear forces in the posterior compartment of the elbow (Eygendaal et al., 2007). Biomechanical analysis reveals that the elbow moves from 116° to 20° flexion within 0.21 seconds during a tennis serve (Eygendall et al., 2007). It has been shown that overhead athletes have a significant decreased ROM in elbow extension and flexion (Wright et al., 2006). Normal ROM for elbow flexion and extension is 0 to 145-155 degrees and for forearm pronation and supination it is 0 to 90 degrees (Starkey, Brown, & Ryan, 2010). When there is a lack of full ROM, athletes can experience a decrease in power and an increased risk of injury (Weerapong, Hume, & Kolt, 2004).

Starrett and Cordoza (2013) proposed the mechanisms behind floss bands include fascial shearing and occlusion of blood to the muscle. Fascia is a type of connective tissue that surrounds the muscles, tendons, nerves, bones, and organs (Prentice, 2011). The compression and movement of floss bands on the muscle alters the relation of the fascia with the neuromusculoskeletal system which allows for the fascia to stretch and move freely (Starrett & Cordoza, 2013). Blood flow restriction (BFR), joint mobilizations, and stretching are all types of therapy that are similar in effects to what floss bands claim to accomplish.

BFR training utilizes a similar application as floss bands but its purpose is to improve muscle strength. BFR uses a band or blood pressure cuff which is wrapped around the muscle belly and

inflated to pressures between 50 to 250 mm Hg (Pope, Willardson, & Schoenfeld, 2013). Greater training adaptations (such as strength and hypertrophy) have been shown when using BFR while performing low intensity exercises (Loenneke, Wilson, Marin, Zourdos, & Bemben, 2011).

Current theories are being studied to determine the exact mechanisms behind BFR. It is hypothesized that by occluding blood flow to the muscle, there is an increase in fiber type recruitment, metabolic accumulation, stimulation of muscle protein synthesis, and cell swelling which results in significant increases in muscle hypertrophy, strength, and endurance (Loenneke et al., 2011). Increases in growth hormone and lactate concentrations have been observed after the use of BFR (Reeves et al., 2006; Takarada et al., 2000). Elevated growth hormone concentrations indicate the stimulation of muscle growth, development, and strength (Reeves et al., 2006). Concentrations of lactate was twice as large after exercise with BFR suggesting that the sympathetic nervous system is stimulated from local hypoxia (Takarada et al., 2000). Floss bands use similar principles and wrapping techniques, however the treatment is much shorter and applied over the joint.

Joint mobilizations are a common manual therapy used to increase range of motion and decrease pain. Heiser, O'Brien, and Schwartz (2013) conducted a systematic review of current evidence for the use of joint mobilizations in treatment of conditions at the elbow, wrist, and hand. For patients with lateral epicondylalgia, more commonly known as tennis elbow, there is moderate evidence that: mobilization with movement will have a positive effect on pain and strength in the short term, elbow mobilizations have a positive effect on ROM in the short term, mobilization is as good or better than a corticosteroid injection in the long term, and joint mobilizations have a positive effect on function in the short and long term (Heiser et al., 2013).

Floss bands claim to have similar increases in ROM as joint mobilizations, however, there is a lack of evidence to support these claims.

Studies have shown there are acute changes in ROM after stretching (Beltão, Ritti-Dias, Pitangui, De Araújo, 2014). There are four main stretching techniques that are used to improve range of motion: ballistic, dynamic, static, and proprioceptive neuromuscular facilitation (PNF) (Weerapong, Hume, & Kolt, 2004). Ballistic stretching is an older stretching technique which involves repetitive bouncing motions to produce quick stretches of the antagonist muscles. Dynamic stretching has become the preferred method of stretching prior to activity because it involves controlled stretches that are more functional in movement. The static stretching technique is widely used because it involves passively stretching an antagonist muscle by placing it in the maximal position of stretch and holding it there. However, it has been shown that using static stretching before exercise can lead to decreases in performance and increased risk in injury (Kay & Blazevich, 2011). The final technique, PNF, involves a combination of altering contractions and stretches which can produce dramatic increases in ROM in one treatment session. According to Weerapong et al. (2004), all of the stretching techniques are all effective in increasing static flexibility which is measured by joint ROM. McMillian, Moore, Hatler, and Taylor (2006) compared dynamic versus static stretching warm up on power and agility performance in 30 military cadets. For three days subjects performed a 10-minute dynamic warm up, static warm up, or no warm up and then completed three tests for power or agility. The authors found that subjects who performed a dynamic warm up had significantly better performance scores in all three tests (McMillian, 2006). Perrier, Pavol, and Hoffman (2011) found an increase in countermovement jump height was greater after dynamic stretching in 21 male athletes compared to static or no stretching. Maintaining flexibility is important because

during sport it is difficult to control for rapid stretch rates. When forces are applied rapidly it will cause the soft tissues (tendons, ligaments, muscles, joint capsules, skin, and fascia) to react in a stiff, brittle fashion resulting in elastic deformation resulting in injury (Weerapong et al, 2004).

### **III. Methods**

#### **A. Design**

A randomized crossover design was used for this study. Participants attended two separate sessions for the independent variable: stretching (control) and floss band (intervention). The dependent variable, ROM for elbow flexion and extension and forearm pronation and supination, was measured using a goniometer. Each participant had at least 24 hours of rest from tennis and the previous session to ensure there is no carryover. According to Reinold et al. (2008) in baseball pitchers ROM changes were present at least 24 hours after throwing, which is why 24 hours was set as the minimum time in between sessions.

#### **B. Participants**

Twelve college-age competitive tennis players (6 men/6 women, mean age  $\pm$  SD;  $20.5 \pm 1.24$  years) were recruited for this study. Participants were excluded from the study if they presented with surgery to the elbow in the past year, known allergy or sensitivity to latex, or compromised circulation in the arms. All participants were instructed about the data-collection procedures and were given a written informed consent form.

#### **C. Measures and Instrumentation**

Measures of elbow flexion and extension and forearm pronation and supination ROM were performed using a handheld manual goniometer (Baseline™ Goniometer, USA). ROM measures were taken before and post intervention for each trial (floss band, Rogue Fitness® Mobility WOD™ Voodoo Floss Band 7', USA, and control). Elbow flexion and extension were

performed with the participant in a supine position, the shoulder in a neutral position, the forearm supinated, and a bolster under the distal humerus (Starkey, Brown, & Ryan, 2010). The fulcrum was centered over the lateral epicondyle, with the stationary arm aligned up through the acromion process along the humerus and the movement arm aligned with the styloid process of the radius. Elbow flexion and extension measures were taken with reference to the neutral ( $0^\circ$ ) position with extension being the neutral position. The inter-rater and intra-rater reliability of elbow flexion and extension had shown good reproducibility (intraclass correlation coefficient (ICC) = 0.48-0.93) using a goniometer (Chunang et al., 2007). Forearm pronation and supination were performed in a seated position with the shoulder in a neutral position, elbow flexed to  $90^\circ$  rested on a table, and a pencil in a tight fist (Starkey, Brown, & Ryan, 2010). The fulcrum of the goniometer was aligned with the head of the third metacarpal with the stationary arm perpendicular to the floor and the movement arm parallel to the pencil. Forearm pronation and supination started in neutral position (forearm horizontal to the floor, palmar aspect of the hand facing medially with the thumb directed upward) which read  $0^\circ$  on the goniometer. The hand-held pencil method of measuring forearm pronation and supination has an acceptable intra- and inter-tester (ICC = 0.86-0.98) reliability using a manual goniometer (Karagiannopoulos, Sitler, & Michlovitz, 2003).

#### **D. Procedures**

Subjects were randomly assigned into treatment or control trial (Random Team Generator, <https://www.randomlists.com>) to determine which intervention was administered first. The goniometric evaluator was blind to which intervention subjects received to control for bias. In order to maintain reliability and provide consistency, the author performed the goniometric measures and one research assistant performed the interventions. For each trial,

participants began by placing an elasticated tubular bandage (Tubigrip™ size D, UK), cut to cover from the mid forearm to mid bicep, on the dominate arm. This was done to cover the marks left on the skin from the floss bands to ensure the author was truly blind as to which intervention was applied. ROM measures were taken three times for each measure and the average of those three measures was used in order to increase reliability of the measures. After baseline ROM was taken, subjects were taken to another room to have an intervention applied. The intervention protocol (band tension, movements, and treatment time) was created in reference to the company's recommendations (Rogue Fitness MobilityWOD). The treatment trail had the floss band applied distal to proximal with approximately 50% tension on the band and each subsequent wrap overlapping the previous by ~50% covering the entire joint and securing the remainder of the band under the final wrap. Once the floss band was applied, the research assistant guided the subject through a series of six ROM exercises with three repetitions for each exercise with the band (see Figure 1 for descriptions and pictures). In preliminary trials the exercise protocol took approximately 2 minutes to complete all of the exercises, however, the participants were not timed during the intervention. The band was taken off immediately if the patient experienced claustrophobia, numbness, or discoloration of the hand. The control trial was taken through the same motions as the treatment trail without the band on. After the intervention was applied, the participants put the elasticated tubular bandage back on before having the ROM measured again under the same standards as stated above.

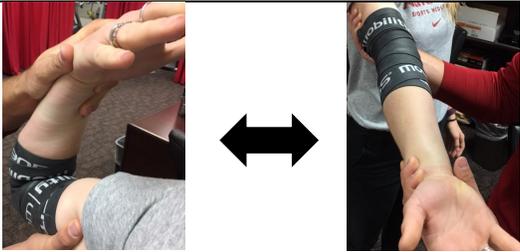
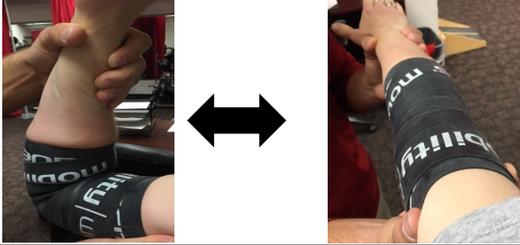
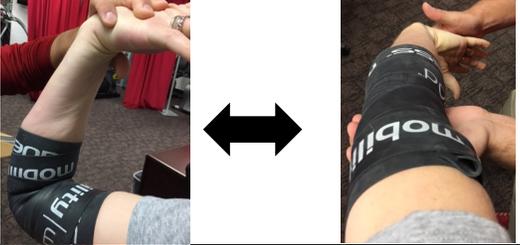
| Figure 1   |             |  |
|--|-------------|--|
| Motion   | Repetitions | Picture  |
| Elbow flexion to elbow extension with wrist and hand in anatomical neutral                                   | 3 times     |    |
| Elbow flexion to elbow extension with forearm pronation  | 3 times     |    |
| Elbow flexion with wrist and hand external rotation to elbow extension with wrist and hand internal rotation | 3 times     |   |
| Elbow flexion with wrist and hand internal rotation to elbow extension with wrist and hand external rotation | 3 times     |  |
| Elbow in extension forearm supinated flexion/extension of the wrist  | 3 times     |  |
| Elbow in extension forearm pronated flexion/extension of the wrist   | 3 times     |  |

Figure 1 – Descriptions and pictures of the movements the subject was guided through during the intervention by the researcher.

### **E. Data Analysis**

Statistical analyses were performed using the Statistical Package for Social Science (V. 23.0, SPSS Inc., Chicago, IL). A paired samples t-test was performed to compare the differences between no band and band for each measure. Statistical significance was set at  $p < 0.05$  for all analysis.

### **IV. Results**

There were no significant differences between floss band and no band for any measures. The results can be found in Table 1 through 3. Although the difference post intervention favored the floss band, it was not at a significant level. Based off Figures 2 through 5 it is easy to see that there is not a significant difference between post band application and post control.

| Paired Samples Test |                       |                    |                |                 |   |         |        |    |                 |
|---------------------|-----------------------|--------------------|----------------|-----------------|---|---------|--------|----|-----------------|
|                     |                       | Paired Differences |                |                 |   |         | t      | df | Sig. (2-tailed) |
|                     |                       | Mean               | Std. Deviation | Std. Error Mean | 95% Confidence Interval of the Difference |         |        |    |                 |
|                     |                       |                    |                |                 | Lower                                     | Upper   |        |    |                 |
| Pair 1              | Pre_Flex - Pre flex2  | 2.16700            | 8.08271        | 2.33328         | -2.96851                                  | 7.30251 | .929   | 11 | .373            |
| Pair 2              | Post_Flex - Postflex2 | -.72392            | 4.78998        | 1.38275         | -3.76732                                  | 2.31949 | -.524  | 11 | .611            |
| Pair 3              | Diff_Flex - Diffflex2 | -2.80275           | 6.64229        | 1.91746         | -7.02306                                  | 1.41756 | -1.462 | 11 | .172            |
| Pair 4              | Pre_Ext - Preext2     | -.19500            | 4.26081        | 1.22999         | -2.90219                                  | 2.51219 | -.159  | 11 | .877            |
| Pair 5              | Post_Ext - postext2   | -1.41725           | 5.08725        | 1.46856         | -4.64953                                  | 1.81503 | -.965  | 11 | .355            |
| Pair 6              | Diff_Ext - Diffext2   | -1.22308           | 3.93229        | 1.13515         | -3.72154                                  | 1.27537 | -1.077 | 11 | .304            |
| Pair 7              | Pre_Pron - prepron2   | .36222             | 8.78213        | 2.53518         | -5.21767                                  | 5.94212 | .143   | 11 | .889            |
| Pair 8              | Post_Pron - postpron2 | -.05442            | 10.07522       | 2.90847         | -6.45591                                  | 6.34708 | -.019  | 11 | .985            |
| Pair 9              | Diff_Pron - Diffpron2 | -.41700            | 5.80360        | 1.67536         | -4.10443                                  | 3.27043 | -.249  | 11 | .808            |
| Pair 10             | Pre_Sup - presup2     | 2.72167            | 7.45570        | 2.15227         | -2.01546                                  | 7.45879 | 1.265  | 11 | .232            |
| Pair 11             | Post_Sup - Postsup2   | 3.02833            | 9.58965        | 2.76829         | -3.06464                                  | 9.12131 | 1.094  | 11 | .297            |
| Pair 12             | Diff_Sup - Diffsup2   | -.14083            | 7.59937        | 2.19375         | -4.96925                                  | 4.68758 | -.064  | 11 | .950            |

Table 1 - No significant differences were found. Flex, flexion; Ext, extension; Pron, pronation; Sup, supination, Diff, difference. First number listed is with no band. Second number (2) is with floss band.

| Paired Samples Statistics |           |          |    |                |                 |
|---------------------------|-----------|----------|----|----------------|-----------------|
|                           |           | Mean     | N  | Std. Deviation | Std. Error Mean |
| Pair 1                    | Pre Flex  | 140.9997 | 12 | 8.44964        | 2.43920         |
|                           | Pre flex2 | 138.8328 | 12 | 12.14821       | 3.50689         |
| Pair 2                    | Post Flex | 143.1667 | 12 | 5.08561        | 1.46809         |
|                           | Postflex2 | 143.8906 | 12 | 6.97951        | 2.01481         |
| Pair 3                    | Diff Flex | 2.1675   | 12 | 4.05000        | 1.16914         |
|                           | Difflex2  | 4.9702   | 12 | 7.57580        | 2.18695         |
| Pair 4                    | Pre Ext   | 2.3050   | 12 | 8.61865        | 2.48799         |
|                           | Preext2   | 2.5000   | 12 | 9.96972        | 2.87801         |
| Pair 5                    | Post Ext  | -1.6392  | 12 | 7.33570        | 2.11763         |
|                           | postext2  | -.2219   | 12 | 11.24373       | 3.24578         |
| Pair 6                    | Diff Ext  | -3.9442  | 12 | 2.70895        | .78201          |
|                           | Diffext2  | -2.7211  | 12 | 2.96063        | .85466          |
| Pair 7                    | Pre Pron  | 83.2508  | 12 | 9.66910        | 2.79123         |
|                           | prepron2  | 82.8886  | 12 | 10.24563       | 2.95766         |
| Pair 8                    | Post Pron | 87.4450  | 12 | 9.78856        | 2.82571         |
|                           | postpron2 | 87.4994  | 12 | 9.29249        | 2.68251         |
| Pair 9                    | Diff Pron | 4.1944   | 12 | 3.64291        | 1.05162         |
|                           | Diffpron2 | 4.6114   | 12 | 5.21990        | 1.50686         |
| Pair 10                   | Pre Sup   | 83.7208  | 12 | 17.98496       | 5.19181         |
|                           | presup2   | 80.9992  | 12 | 18.60201       | 5.36994         |
| Pair 11                   | Post Sup  | 84.7508  | 12 | 21.10092       | 6.09131         |
|                           | Postsup2  | 81.7225  | 12 | 16.84814       | 4.86364         |
| Pair 12                   | Diff Sup  | 1.0275   | 12 | 5.11196        | 1.47570         |
|                           | Diffsup2  | 1.1683   | 12 | 5.01736        | 1.44839         |

Table 2 – Data are mean degrees for all subjects. Flex, flexion; Ext, extension; Pron, pronation; Sup, supination, Diff, difference. First number listed is with no band. Second number (2) is with floss band.

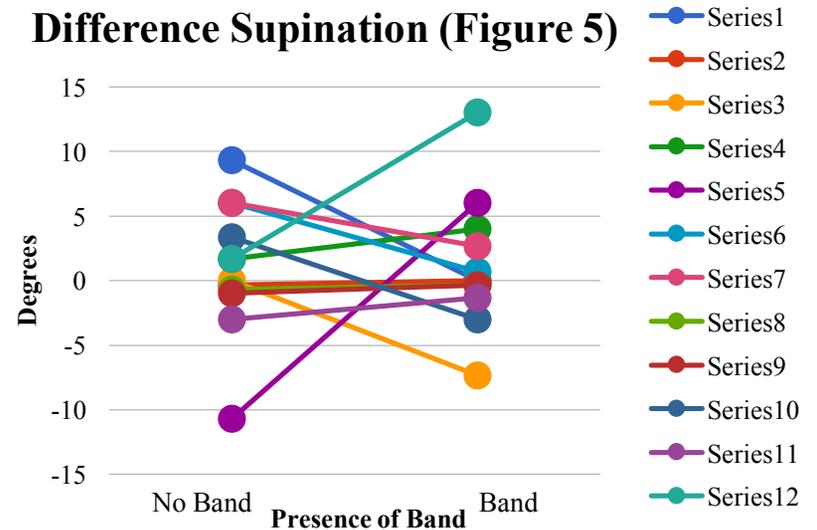
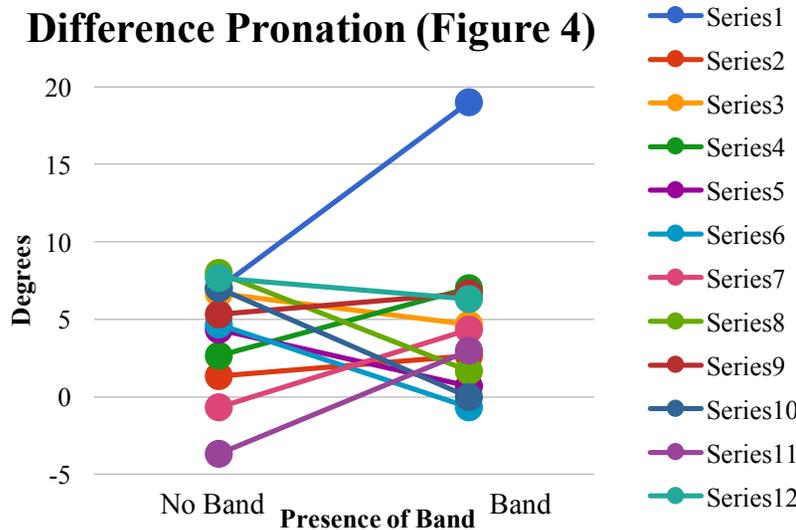
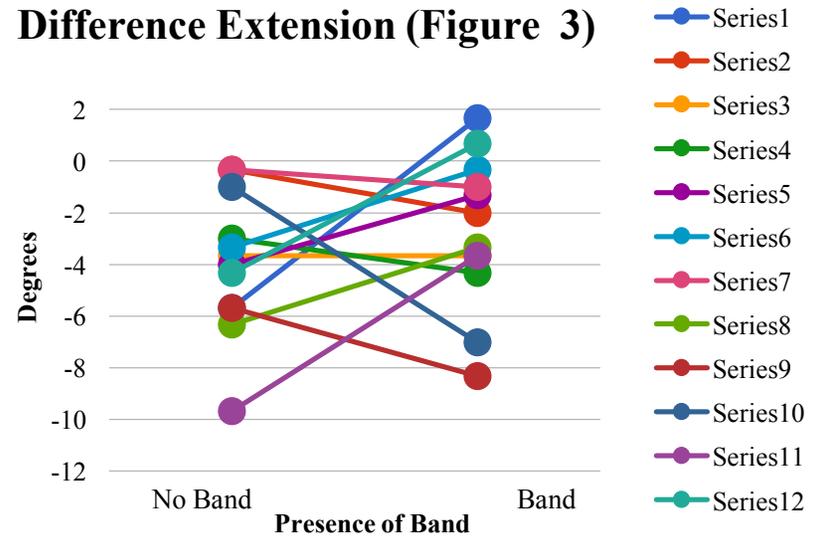
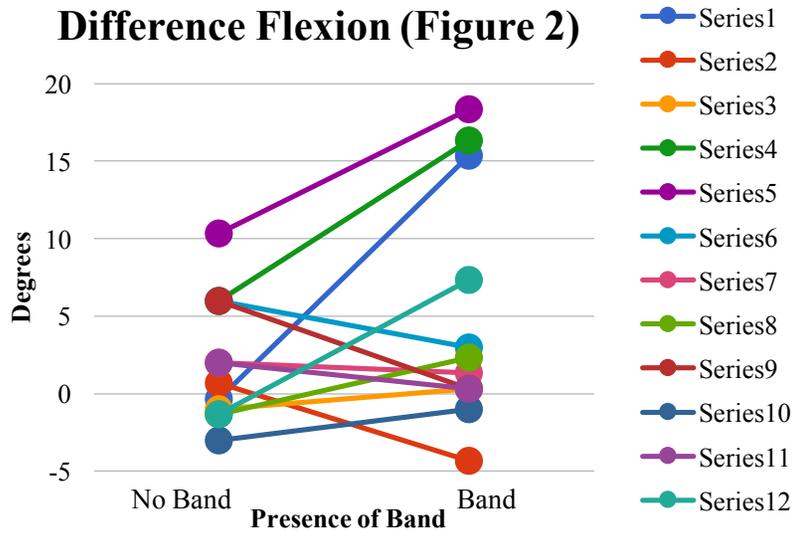


Figure 2-5 – Post measure comparison for No Band and Band for each subject. No significant changes were found.

## V. Discussion

This is the first study to investigate the use of floss bands on elbow flexion and extension and forearm pronation and supination in elite athletes. The findings indicate there is no significant benefit from using floss bands to improve ROM ( $p < 0.05$ , Table 1). This suggests that floss bands are not effective in increasing ROM in the elbow. Although, some participants (Series 1 and Series 4 in Figures 2-5) saw a mean increase in ROM after the use of the floss bands, these subjects presented initially with a restriction in motion.

Although this is the first study to evaluate the use of floss bands on the elbow, the results support the only other study to investigate the use of floss band on the upper extremity (Plocker et al., 2015). Plocker et al. (2015) did not find any significant improvements in shoulder ROM or upper-extremity power after the use of the floss bands. However, these results refute the only other previous study to evaluate the use of floss bands in the acute setting. Driller and Overmayer (2017) found significant improvements in all ankle ROM measures and in single-leg jump performance after the application of the floss band in 52 recreational athletes. However, all results were association with a small effect size ( $\pm 0.2$ ) (Driller & Overmayer, 2017). The only other study to investigate the use of floss bands was in a chronic (14-day) setting which found an increase in dorsiflexion peak torque (Bohlen et al., 2014).

There is an enormous amount of force across the elbow during tennis strokes which results in valgus and extension overload over the joint (Eygendaal et al., 2007). The force production generates power to hit the tennis ball. These forces place the ligamentous, osseous, musculotendinous, and neural structures of the elbow at an increased risk for injury (Eygendaal et al., 2007). It has been shown that elite tennis players have significantly reduced ROM in the dominant arm compared to the non-dominant (Ellenbecker et al., 2002). Due to this lack of

ROM, tennis players would be more likely to see ROM benefits from the floss bands compared to the average population.

The exact physiological mechanism behind floss bands is yet to be determined. However, floss bands provide partial vascular occlusion which may produce numerous physiological responses after the band is removed. It has been shown that BFR results in increased muscular strength, hypertrophy, localized endurance, and cardiorespiratory endurance via neuromuscular and endocrine adaptations (Loenneke et al., 2011; Pope et al., 2013). Takarada et al. (2000) found an increase in growth hormone, norepinephrine, and lactate concentrations after exercise with occlusion. These hormone levels indicate that when blood flow is occluded training responses are present with lower intensity exercises (Pope et al., 2013). The increase in localized blood flow post band removal may play a role for the use of floss bands, however this has not been studied.

A limitation of this study was the small sample size. Results could have been influenced by a larger group. Another limitation was that the band application was done by hand, so the tension could have varied between participants. However, this potential limitation was minimized by using the same individual apply the band for all participants. A further limitation could be attributed to the that the test subjects subconsciously tried harder to improve their ROM after the intervention was applied.

Further research should investigate the physiological effects of floss bands. Although this study found no significant benefits in ROM after using the floss band, the localized blood flow and hormonal response may contribute to other benefits of floss bands. Further research is also warranted to investigate the psychological effects of using floss bands. Although it was not evaluated in this study, many subjects reported “feeling better” and a perceived improvement in

ROM after the use of the floss bands. Future research should investigate the effects of placebo with the use of floss bands.

## **VI. Conclusion**

This study is the first to investigate the use of floss bands to improve elbow ROM in elite level tennis players. The results suggest that floss bands do not significantly improve elbow ROM compared to other treatment methods. Floss bands may have other applications in sport, however for increasing ROM, this study indicated that floss bands are not significantly useful.

## VII. References

- Beltão, N., Ritti-Dias, R., Pitangui, A., & De Araújo, R. (2014). Correlation between Acute and Short-Term Changes in Flexibility Using Two Stretching Techniques. *International Journal of Sports Medicine*, 35, 1151-1154.
- Bohlen, J., Arsenault, M., Deane, B., Miller, P., Guadagno, M., & Dobrosielski, D. (2007). Effects of applying floss bands on regional blood flow. *International Journal of Exercise Science: Conference Proceedings*, 9(2).
- Chunang, Y., Chang, Y., Hshiao, Y., Wu, W., Huang, Y., Chuan, T., & Chang, H. (2007). Test-retest reliability and inter-rater reliability of elbow range of motion measurement. *Journal of Biomechanics*, 40(2), S630.
- Donatelli, R., & Wooden, M. J. (2001). *Dysfunction, evaluation, and treatment of the elbow*. (4 ed.). New York: Churchill Livingstone.
- Driller, M. W., & Overmayer, R. G. (2017). The effects of tissue flossing on ankle range of motion and jump performance. *Physical Therapy in Sports*.
- Ellenbecker, T., Roetert, E., Bailie, D., Davies, G., & Brown, S. (2002). Glenohumeral joint total rotation range of motion in elite tennis players and baseball pitchers. *Medicine & Science in Sports & Exercise*, 34(12), 2052-2056.
- Eyendaal, D., Rahussen, F. T., & Diercks, R. L. (2007, July 17). Biomechanics of the elbow joint in tennis players and relation to pathology. *British Journal of Sports Medicine*, 41(11), 820-823.
- Heiser, R., O'Brien, V. H., & Schwartz, D. A. (2013). The use of joint mobilization to improve clinical outcomes in hand therapy: A systematic review of the literature. *Journal of Hand Therapy*, 26(4), 297-311.
- Karagiannopoulos, C., Sitler, M., & Michlovitz, S. (2003). Reliability of 2 functional goniometric methods for measuring forearm pronation and supination active range of motion. *Journal of Orthopaedic & Sports Physical Therapy*, 33(9), 523-531.
- Kay, A., & Blazevich, A. (2011). Effect of acute static stretch on maximal muscle performance: a systematic review. *Medicine & Science in Sports & Exercise*, 44(1), 154-164.
- Loenneke, J. P., Wilson, J. M., Marín, P. J., Zourdos, M. C., & Bemben, M. G. (2011). Low intensity blood flow restriction training: A meta-analysis. *European Journal of Applied Physiology*, 112(5), 1849-1859.
- McMillian, D., Moore, J., Hatler, B., & Taylor, D. (2006). Dynamic vs. static-stretching warm up: the effect on power and agility performance. *Journal of Strength and Conditioning Research*, 20(3), 492-499.

- Perrier, E., Pavol, M., & Hoffman, M. (2011). The acute effects of a warm-up including static or dynamic stretching on countermovement jump height, reaction time, and flexibility. *Journal of Strength and Conditioning Research*, 25(7), 1925-1931.
- Plocker, D., Wahlquist, B., & Dittrich, B. (2015). Effects of tissue flossing on upper extremity range of motion and power. *International Journal of Exercise Science: Conference Proceedings*, 12(1), 37th ser.
- Pope, Z., Willardson, J., & Schoenfeld, B. (2013). Exercise and blood flow restriction. *Journal of Strength and Conditioning Research*, 27(10), 2914-2926.
- Prentice, W. E. (2011). *Principles of athletic training: A competency-based approach* (14 ed.). New York, NY: McGraw Hill.
- Reeves, G., Kraemer, R., Hollander, D., Clavier, J., Thomas, C., Francois, M., & Castracane, V. (2006). Comparison of hormone responses following light resistance exercise with partial vascular occlusion and moderately difficult resistance exercise without occlusion. *Journal of Applied Physiology*, 101(6), 1616-1622.
- Reinold, M., Wilk, K., Macrina, L., Sheheane, C., Dun, S., Fleisig, G., . . . Andrews, J. (2008). Changes in shoulder and elbow passive range of motion after pitching in professional baseball players. *American Journal of Sports Medicine*, 36(3), 523-527.
- Starkey, C., Brown, S. D., & Ryan, J. (2010). *Elbow and forearm pathologies. In Examination of orthopedic and athletic injuries* (3 ed.). Philadelphia: F.A. Davis.
- Starrett, K., & Cordoza, G. (2013). Becoming a Supple Leopard: The Ultimate Guide to Resolving Pain, Preventing Injury, and Optimizing Athletic Performance. In *The Systems* (pp. 217-222). Las Vegas, NV: Victory Belt Publishing Inc.
- Takarada, Y., Nakamura, Y., Aruga, S., Onda, T., Miyazaki, S., & Ishii, N. (2000). Rapid increase in plasma growth hormone after low-intensity resistance exercise with vascular occlusion. *Journal of Applied Physiology*, 88(1), 61-65.
- Weerapong, P., Hume, P. A., & Kolt, G. S. (2004). Stretching: Mechanisms and Benefits for Sport Performance and Injury Prevention. *Physical Therapy Reviews*, 9(4), 189-206.
- Wright, R., Steger-May, K., Wasserlauf, B., O'Neal, M., Weinberg, B., & Paletta, G. (2006). Elbow range of motion in professional baseball pitchers. *American Journal of Sports Medicine*, 34(2), 190-193.

## VIII. Appendices

### A. Consent Form

The Effect of Floss Bands On Elbow Range of Motion in Tennis Players Consent to Participate  
in a Research Study

Principal Researcher: Kenna Hodeaux

Faculty Advisor: Stephen Dittmore

#### INVITATION TO PARTICIPATE

You are invited to participate in a research study about the effects of floss bands on range of motion. You are being asked to participate in this study because you are a division one tennis player.

#### WHAT YOU SHOULD KNOW ABOUT THE RESEARCH STUDY

##### *Who is the Principal Researcher?*

Kenna Hodeaux  
khodeaux@uark.edu  
520-909-7768

##### *Who is the Faculty Advisor?*

Stephen Dittmore  
dittmore@uark.edu  
479-575-6625

##### *What is the purpose of this research study?*

Compare functional movement stretching and floss bands effects on elbow range of motion (ROM) in tennis players.

##### *Who will participate in this study?*

Competitive tennis players, male and female, ages 17-23. The participants will be recruited via word of mouth with contacts we have in UREC and University athletics and participation in the study will remain completely voluntary.

##### *What am I being asked to do?*

Your participation will require the following: Allow measurements of elbow range of motion (elbow flexion and extension and forearm pronation and supination) on both arms, the application of the floss band, and be taken through a range of motion (flexion, extension, pronation, supination) with the floss band on and off.

##### *What are the possible risks or discomforts?*

It is possible to feel discomfort with the band on resulting in claustrophobia, numbness in the hand/arm, and lack of blood flow to the extremity. These signs and symptoms are temporary and are alleviated once the band is removed. The band is immediately removed if any of these symptoms occur.

*What are the possible benefits of this study?*

Increased range of motion in the elbow.

*How long will the study last?*

Two meetings, approximately 30 minutes each for measurement and application. On the first visit they will take their baseline ROM and be assigned and tested in the floss band group or stretching group. On the second visit, they will have their baseline ROM measured again and be tested in the group that they were not initially tested in (i.e. First visit – floss band, second visit – stretching). There is a minimum of 12 hours between meetings.

*Will I receive compensation for my time and inconvenience if I choose to participate in this study?*

No.

*Will I have to pay for anything?*

No.

*What are the options if I do not want to be in the study?*

If you do not want to be in this study, you may refuse to participate. Also, you may refuse to participate at any time during the study. Your job, your grade, your relationship with the University, etc. will not be affected in any way if you refuse to participate.

*How will my confidentiality be protected?*

All information will be kept confidential to the extent allowed by applicable State and Federal law. All collected data will be anonymous and stored only with the principal researcher.

*Will I know the results of the study?*

At the conclusion of the study you will have the right to request feedback about the results. You may contact the faculty advisor, Stephen Dittmore, [dittmore@uark.edu](mailto:dittmore@uark.edu), 479-575-6625 or the Principal Researcher, Kenna Hodeaux, [khodeaux@uark.edu](mailto:khodeaux@uark.edu), 520-909-7768. You will receive a copy of this form for your files.

*What do I do if I have questions about the research study?*

You have the right to contact the Principal Researcher or Faculty Advisor as listed below for any concerns that you may have.

Kenna Hodeaux  
[khodeaux@uark.edu](mailto:khodeaux@uark.edu)  
 520-909-7768

Stephen Dittmore  
[dittmore@uark.edu](mailto:dittmore@uark.edu)  
 479-575-662

You may also contact the University of Arkansas Research Compliance office listed below if you have questions about your rights as a participant, or to discuss any concerns about, or problems with the research.

Ro Windwalker, CIP Institutional Review Board Coordinator Research Compliance University of Arkansas 109 MLKG Building Fayetteville, AR 72701-1201 479-575-2208 [irb@uark.edu](mailto:irb@uark.edu)

I have read the above statement and have been able to ask questions and express concerns, which have been satisfactorily responded to by the investigator. I understand the purpose of the study as well as the potential benefits and risks that are involved. I understand that participation is voluntary. I understand that significant new findings developed during this research will be shared with the participant. I understand that no rights have been waived by signing the consent form. I have been given a copy of the consent form.

Signature: \_\_\_\_\_ Date: \_\_\_\_\_

IRB #16-09-116 Approved: 10/18/2016 Expires: 10/10/2017

## B. Research Compliance Protocol Letter



Office of Research Compliance  
Institutional Review Board

October 19, 2016

### MEMORANDUM

TO: Kenna Hodeaux  
Brendon McDermott  
Terry Eddy  
Christopher Blaszk  
Stephen Dittmore

FROM: Ro Windwalker  
IRB Coordinator

RE: New Protocol Approval

IRB Protocol #: 16-09-116

Protocol Title: *The Effect of Floss Bands on Elbow Range of Motion in Tennis Players*

Review Type:  EXEMPT  EXPEDITED  FULL IRB

Approved Project Period: Start Date: 10/18/2016 Expiration Date: 10/10/2017

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (<https://vpred.uark.edu/units/rscp/index.php>). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

**This protocol has been approved for 50 participants.** If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or [irb@uark.edu](mailto:irb@uark.edu).