University of Cincinnati

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I, Mallory Kohn, hereby submit this original work as part of the requirements for the degree of Master of Science in Health Education (Exercise & Fitness).

It is entitled:
The Effect of the Graston Technique on Talocrural Range of Motion

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Committee member: Thomas Palmer, Ph.D.
The Effect of the Graston Technique on Talocrural Range of Motion

A thesis submitted to the Graduate School of the University of Cincinnati
In partial fulfillment of the requirements for the degree of

Master of Science

In the Department of Health Education, Concentration in Exercise Management College of Education, Criminal Justice, and Human Services

By

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Bachelor of Science in Athletic Training
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Committee Chair: Dr. Bradley Wilson
Faculty Advisor: Dr. Thomas Palmer
ABSTRACT

Context: Many clinicians perform a variety of manual therapy techniques to increase range of motion. The Graston Technique (GT) is a less commonly used instrument assisted soft tissue mobilization (IASTM) technique, but assumed to increase range of motion. **Objective:** The purpose of this study was to determine the effect the Graston Technique has on dorsiflexion (DF) at the talocrural joint of the ankle. **Design:** A randomized control trial. **Patients or Other Participants:** Fifty healthy Division 1 NCAA track and field athletes, male (n=21, ht 183.79cm ± 6.09cm, wt 77.52kg ± 9.98kg) and female (n= 29, ht 171.19cm ± 6.35cm, wt 67.47kg ± 14.24kg), with the average age 20 ± 1.3 volunteered for this study. **Intervention:** Participants were randomly selected to one of three treatment groups: Graston Treatment group with stretching (GT), a Traditional stretching exercise group (TS) and a traditional control group (C). Treatments were on the individual’s right leg for 10 minute sessions, done twice a week over a course of three weeks for a total of 6 treatments. **Main Outcome Measures:** The primary dependent variables were active ankle dorsiflexion non-weight bearing degrees of motion at the talocrural joint (NWt-DF), close kinetic chain weight-bearing knee to wall measures in degrees of ankle dorsi-flexion at the talocrural joint (Wt-DF) and the knee to wall distance of the foot to the wall in centimeters (F-cm). **Results:** The change score for Wt-DF and F-cm was significantly greater by nearly 2 and 8% respectively in the GT when compared to the TS group, (p< .05) at post-intervention, which supports the hypothesis that the Graston Therapy would have an added effect on talocrural joint dorsiflexion ROM. **Conclusions:** A GT protocol of IASTM and endurance active ROM has better effect than a traditional stretching program for improving talocrural dorsiflexion ROM in healthy subjects. GT or IASTM provides additional mobility of fascia that stretching cannot achieve and improves range of motion more significantly,
particularly when weight bearing. **Key Words:** Graston Technique, myofacial release, manual therapy, fascia.
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INTRODUCTION

The Graston Technique (GT) is a form of instrument assisted manual therapy used to increase range of motion (ROM). Significant results from GT have been reported to reduce pain and improve performance, however, there is little evidence of the effects GT has on increased ROM within a healthy population (7, 10, 14). ROM can be gained due to an increase of tissue vascularity, increasing elasticity of the surrounding joint. Gains of ROM have been associated with decreased chance of injury such as muscles strains, Achilles tendonitis, and plantar fasciitis (8, 18, 22). The American College of Sports Medicine (ACSM) suggests a stretching protocol consisting of a volume of two treatments per week for 4-6 weeks to develop increased ROM in healthy muscle tissue (20).

Other forms of manual therapy, such as massage, soft tissue mobilization (STM) and myofascial release techniques have been reported to increase tissue blood flow, increasing elasticity of fibers and therefore, elongate tissues (3, 19). Residual therapeutic effects of increased ROM include decreased pain and functional mobility. GT is an instrument assisted soft tissue mobilization technique (IASTM) that uses stainless steel instruments (Figure 1) with beveled edges to augment a clinician’s ability to perform STM on fascial restrictions. Micro- and macro-trauma to the fascia have been reported to cause fibrous adhesions to form resulting in a loss of fascial elasticity. These adhesions can be painful and reduce the muscle fibers normal mechanical motion due to their loss of gliding capability and mobility (15, 21). GT targets abnormalities from the increased tactile diagnostic feedback in the soft tissue fascia through multidirectional strokes in varying angles. IASTM treatments have also been reported to restart the inflammation process by enhancing proliferation of cells which facilitates the realignment of fibers (2, 3, 17). The various sizes and shapes of IASTM instruments allows for clinicians to
treat the different contours of the myofascial restrictions (3).

GT is hypothesized to increase range of motion when performed on targeted tissues (12). However, due to the lack of evidence regarding GT, there is uncertainty that it increases range of motion more than traditional stretching programs. Since GT provides a similar mechanical load as other manual therapy techniques, such as massage, STM, myofascial release, etc., we hypothesize that GT will increase range of motion of targeted tissues. Therefore, the purpose of this study is to investigate the effects of the Graston Technique on the talocrural joint. Secondary objectives included examining the relationship among non-weight bearing dorsi-flexion, weight bearing dorsi-flexion in degrees and weight-bearing dorsi-flexion in centimeters from the wall.

**Figure 1: Graston Instruments 2-6 (shown in order)**

PROCEDURES and FINDINGS:

**Design**

A randomized control trial, cohort, pre-post-test study design was used to test the independent variables of the Graston Technique and a stretching protocol. The dependent variables were non-
weight bearing dorsiflexion (DF), knee to wall in degrees of dorsiflexion (Wt-DF) at the talocrural joint and knee to wall in centimeters (F-cm).

**Subjects**

Fifty healthy, Division I collegiate male (n=21) and female (n=29) track and field athletes with a mean age = 20 ± 1.3, height = 177.57 ± 8.34 cm, weight = 72.5 ± 13.19 kg from the same university volunteered to participate in a three week mobility training intervention (Table 1). Participants were randomly assigned to one of three training groups; a traditional stretch (TS) training group (n=14), a Graston Therapy (GT) training group (n=19) or a non-intervention control (C) training group (n=17). The TS training group was composed of 7 females and 7 males with a mean age = 20.3 ± 1.3 years, height = 176.3 ± 8.6 cm, pre-intervention weight = 80.1 ± 13.8 kg. Nineteen participants of the GT training group were composed of 9 females and 10 males with a mean age = 19.8 ± 1.2, height = 179.2 ± 9 cm, pre-intervention weight = 74.1 ± 12.3 kg. The C training group was composed of 9 females and 8 males with a mean age = 19.8 ± 1.2, height = 168.2 ± 8.2 cm, pre-intervention weight = 73.1 ± 12.3 kg. Inclusion criteria consisted of collegiate athletes with no major orthopedic injury within the past six months resulting in the inability to perform sport training activities. Participants reported to an information meeting where they reviewed and signed an informed consent document. All 50 subjects participated in a familiarization period, baseline data collection, and post-intervention data collection. Participants were informed of the treatment procedures and any adverse reactions that may occur with GT, such as redness, swelling, and bruising of treatment site. The intervention period was three weeks with two treatments per week. There were no reported drop-outs. On average each participant attended 88 ± 8% for training interventions. Testing and
interventions occurred during the spring season. Study protocol and procedures were approved by a University Institutional Review Board.

**Procedures**

Prior to data collection, all of the participants were informed not to change their daily habits or perform any physical activity other than standard practices. Baseline testing and familiarization of GT protocol, Wt-DF, NWt-DF and F-cm measures were performed on all participants prior to treatment intervention. Each participant attended a minimal of two familiarization sessions to account for a learning effect.

*Measures:*

NWt-DF was measured prone with knee flexed at 90 degrees. The subjects were instructed to DF their ankle as far as they could and were measured with a goniometer (6). The average of three measurements were recorded. The Wt-DF measure (8) had the participants stand with their heel in contact with the ground (Figure 2). They were instructed to wear socks to allow better movement of their foot on the tile floors. A ruler taped to the floor was used to document the patients’ measurement in cm. For balance, subjects were allowed to use two fingers from each hand on the wall. Starting with their great toe at 10 cm, subjects were to lunge forward, directing their knee to the wall in line with their second toe until their knee touched the wall. The foot was progressed away from the wall 1 cm at a time and instructed to repeat the lunge until they were unable to touch the wall with their knee while keeping their heel on the floor. Once the knee could no longer contact the wall or the heel could no longer maintain contact with the floor, the foot was moved in one centimeter increments toward the wall for their final measurement. If the patients could not reach their knee to the wall at the initial 10 cm mark, they were instructed to
progressively move their big toe forward until their knee touched the wall. Measurements taken were distance of the great toe to the wall in centimeters and eccentric DF of the talocrural joint in degrees (8, 13, 23).

**Figure 2: Weight Bearing Dorsiflexion (Wt-DF)**

*Interventions:*

Participants were randomly assigned to three groups: those receiving the Graston Technique (GT), those receiving only a traditional stretching protocol (TS) and a control group receiving no treatment (C). Group TS and GT received treatments on the right leg twice a week for three weeks, while the control was asked to maintain normal activity levels. The GT group received a 10-minute choreographed protocol covering the proximal portion of the gastrocnemius distally to the ankle, foot, and metatarsal heads. After GT intervention, 20 heel raises and 20 plantar flexion pumps using black tubing were performed (Figure 3 A&B). A static stretch for the posterior musculature of the foot and ankle was performed with a neutral food on a slant board 3 times for 45 seconds isolating both the gastrocnemius and soleus (17) (Figure 4 A&B). The TS group performed only the stretching/exercise protocol used by the GT
group. Post treatment measurements were recorded for all participants following treatment intervention.

The GT protocol

For the GT protocol patients were positioned lying prone on a treatment table. The patients’ treated leg had a bolster underneath their shin, proximal to the ankle joint, putting the knee in slight flexion, allowing the investigator greater access to treatment area. The investigator applied a small amount of emollient gel to the entire gastrocnemius and soleus complex, Achilles tendon and plantar fascia. The treatment was initiated with GT-5 in a mild downward sweeping motion to the heads of the gastrocnemii as well as the belly of the muscle, making sure not to come in contact with the fibular head. At 2 minutes, GT-5 was used in an upward motion, making sure to treat both lateral and medial gastrocnemius and soleus. The total treatment of the gastrocnemius/soleus was 4 minutes. Treatment of the Achilles tendon was next. With the ankle in slight DF, GT-2, double beveled edge, was used in a downward sweeping motion focusing primarily on the musculotendinous junction. After one minute, the instrument was used in an upward sweeping motion. At minute 2, GT-3 was used in short strokes perpendicular to the tendon treating the lateral and medial sides of the Achilles tendon for 30 seconds each. Total treatment of the Achilles tendon was 3 minutes. Lastly, the plantar fascia was treated. Still maintaining slight ankle DF, the toes were extended, to better expose the plantar fascia. Using GT-3, the investigator started at the distal attachment of the Achilles moving to the plantar aspect of the calcaneus and calcaneal tubercles. Short strokes in upward and downward motion were used switching the direction of their strokes 30 seconds into the treatment. After one minute, GT-4 was applied in a downward sweeping motion focusing on the medial aspect of the plantar fascia for approximately 30 seconds followed by an upward sweeping motion for 30 seconds.
While maintaining toe extension, GT-6 was applied using the pointed edge in short strokes circumducting each individual metatarsal head for approximately 20 seconds per metatarsal head. The Graston protocol took 10 minutes to complete.

Based on numerous studies, positive effects from these particular instruments have been shown on pathologic patients (7). The instruments used in this study were specifically chosen based on the size of the tissues being treated and the goal of the treatment (Figure 1). GT 4 and 5 are best known as the effleurage instruments covering larger areas, where GT 2, 3, and 6 are better used for smaller specific treatment areas. Interventions and data collection occurred in a controlled laboratory on a university campus. The research team consisted of two certified athletic trainers who are both M1 Graston Technique certified and trained professionally in other manual therapies. The lead investigator has four years of experience using GT on patients.

**Figure 3: (A) Heel Raises, (B) Tubing Ankle Pumps**
Figure 4: (A) Gastrocnemius Stretch, (B) Soleus Stretch.

DATA ANALYSIS

A randomized control trial was implemented with a pre- to post-intervention design. The independent variables were the traditional stretch training group (TS), the Graston Technique training group (GT), and the traditional control training group (C). The primary dependent variables were active ankle dorsiflexion non-weight bearing degrees of motion at the talocrural joint (NWt-DF), close kinetic chain weight-bearing knee to wall measures in degrees of ankle dorsiflexion at the talocrural joint (Wt-DF) and the knee to wall distance of the foot to the wall in centimeters (F-cm).

Normality of the distribution was assessed with a Shapiro-Wilk test and visual observation of the residual plots for the pre- and post-intervention measures. Baseline pre-intervention values were examined for group differences using a One-way ANOVA. Group differences for each dependent variable were assessed using the change score at post-intervention with a 3x2 (Group x Time) Two Way ANOVA and a LSD post hoc analysis. The treatment
effect between the groups was further analyzed by calculating effect sizes (ES) with corresponding 95% confidence intervals (CI) for each dependent variable. ES was based on a Cohn’s $d$ calculation; respectively each intervention groups’ mean was subtracted by the mean of the tradition C group and divided by a pooled standard deviation to determine the effect of each intervention. ES data are displayed in Table 2 and were interpreted as small ($0–0.39$), medium ($0.40–0.69$) or large ($\geq 0.70$).

A secondary analysis was performed using a Pearson Product Moment correlation to assess the relationships between the NWt-DF, Wt-DF, and the F-cm outputs. Treatment compliance was analyzed via descriptive methods. All statistical analyses were performed using SPSS/PAW v19.0 (SPSS, IMB Inc., Chicago, IL.) with an a priori significance level of $p \leq .05$.

RESULTS

There were no between group differences at baseline for subject height, weight and ROM dependent measures reported in Table 1, ($p > .01$). Between groups differences at post-intervention are displayed in Tables 2. There was a significant group x time main effect for the TS and GT groups with improved range of motion (ROM) at the talocrural joint for degrees as measured by a goniometer NWt-DF ($TS= 1.9\pm .5$, $GT= 2.0\pm .4$, $F=.6$, $df= 2$, $p= .01$) and in centimeters F-cm ($TS= 1.2\pm .4$, $GT= 2.7\pm .5$, $F=.18$, $df= 2$, $p= .01$), when compared to the traditional control group. However, there was no group x time interaction between the GT and TS groups for the NWt-DF. A main effect for the GT group was also evident for degrees of motion as measured by a goniometer for the Wt-DF ($GT= 2.8\pm 2.6$, $F= .6$, $df= 2$, $p= .01$) and the F-cm ($GT= 2.7\pm .5$, $F=.18$, $df= 2$, $p= .01$) when compared to the TS and C group. There was no main effect detected in the C group for all dependent variables. The change score for Wt-DF and F-cm was significantly greater by nearly 2 and 8% respectively in the GT when compared to the
TS group, (p< .05) at post-intervention, which supports the hypothesis that the Graston Technique would have an added effect on talocrural joint dorsiflexion ROM (Table 3).

The between groups treatment effect is displayed in Table 2. The treatment effect was large for Wt-DF for the TS group (TS= 1.0, CI= -.57-.2.46) and for the GT group (GT= .9, CI=.1-1.81). The TS also recorded a large effect for the F-cm (TS= .8, CI= -.19-1.79) while the GT group had a medium effect (GT= .6, CI=.03-.37). Small effects were also observed for all three groups with the C group recording minimal to no effect.

Significant moderate to strong relationships were found between all dependent variables (Table 4). The moderate to low, yet significant correlations suggest the weight bearing assessments are relatively repetitive (.24-.54). Subject training compliance exceeded 90 percent for the GT and TS intervention groups.

DISCUSSION

We hypothesized that the Graston Technique would have statistical significance on ROM at the talocrural joint when compared to a traditional stretching program and a control protocol. Our data support GT to be more effective in promoting ROM when compared to C group in all three measurements (Wt-DF, F-cm and NWt-DF) and in two of the three measures (Wt-DF, F-cm) when compared to a traditional stretching group (p <.05). Clinically, the effect size and shared variance in our data suggest that the GT and TS seem to be very similar treatment options. However, our findings for the non-weight bearing ROM assessment suggest GT, which naturally includes the characteristics of a traditional stretching protocol, to be a superior treatment when compared to our traditional stretching protocol when weight bearing ROM is a desired therapeutic outcome at the talocrural joint (16). Traditional GT is accompanied with instrumental
massage followed by a static stretch and dynamic endurance exercises (12). Our protocol followed this format therefore; our results showed that GT combined with stretching and exercises enhance a typical TS protocol. The improvement in the GT group was 2.8± 2.6 cm improvement (Wt-DF) in ROM over C (.4± .3cm) was likely due to the increased elasticity of the tissues when compared to those in the TS group. As previously mentioned, GT is categorized as a manual massage therapy with similar mechanical effects and is stated to improve blood and lymph flow resulting in increased elasticity and mobility of the tissue (5, 9). We can now deduce that this increased elasticity is also the cause of the statistical significance when comparing GT (2.8± 2.6) to TS (1.3± 2.9) in Wt-DF measurement. It appears that IASTM compliments a typical TS protocol.

Our results support a traditional weight bearing stretching protocol as previous reports have shown similar effects (6). Previous findings validate that our intervention consisted of valid treatment volume and intensities necessary to promote change to soft tissue elastic properties (20). However, when TS was compared to the C group, it was only shown to increase ROM in 2 out of the 3 measurements (NWt-DF, F-cm). Dinh et al. (6) found that there is no significant difference in ankle DF ROM between non weight bearing (p= 0.49) and weight bearing (p= 0 .86) measures. Although Dinh et al. states that one measurement is not better than the other, our data suggest the contrary (6). It appears that GT improves the Wt-DF due to increased mobility of the fascia that a traditional stretching protocol cannot achieve.

The most significant improvement of ROM out of the 3 measures for GT was F-cm, also known as the Ankle Lunge Test (ALT). Although F-cm generally has an excellent inter- and intra-rater reliability (ICC> 0.85 and CI: 0.96-0.99) when measuring DF at the talocrural joint, there are potential factors that may have influenced our measures (23). Konor et al. (13) states
weight bearing subtalar and foot position, specifically when pronated, may allow more DF than non-weight bearing. Since the knee to wall test focuses primarily on assessing ankle dorsi- and plantar-flexion at the talocrural joint, it is difficult to decipher how accessory motions of the subtalar joint may have contributed to the patients’ measurements. Some patients may have had more pronation than others, thus increasing their DF more significantly. However, we are confident in the clinical experience of our primary investigator and the utility of the testing protocol in minimizing measurement error. Another factor that may have influenced DF measures is previous injuries patients may have suffered prior to testing. Exclusions were made of those who had suffered a lower leg injury 6 months prior to the study, however, it is known that previous injury to the talocrural joint can reduce DF permanently due to possible contractures and thickening at the healing site thus reducing extensibility (11, 21).

Traditional stretching and manual therapies are designed to facilitate fascia elasticity. Fascia is a continuous structure that surrounds and integrates tissues throughout the body and varies in thickness and density and affects the relationship among the structures it surrounds (1, 9). Without fascia, tissues would lack lubrication, function and support. Although fascia has high tensile strength and is able to bear different forces, injury can alter and affect the mechanical properties of fascia (21). When there is injury to the body such as inactivity or inflammation, fascial tissue loses elasticity and becomes dehydrated. It then binds to its surrounding tissues causing fibrous adhesions to form (15). These adhesions become dense and thick causing pain, preventing normal muscle mechanics of motion, and decreasing soft tissue extensibility (1, 15, 21). IASTM, a form of myofascial release, was designed to help reduce these fibrous adhesions and restrictive barriers to decrease pain and return normal activity. The improvements noted in both the GT and TS group suggest our treatment protocols likely resulted in a positive elastic
effect to the muscle and possibly the fascia. It is reasonable to consider the combination of GT and stretching verse traditional stretching aids in enhancing mobility at the talocrural joint. It can be surmised that the GT group treatment targeted fascia beyond that of the traditional stretching. Previous reports support facilitated and increases in isolated tissue adhesions commonly reported to occur in muscle of healthy active populations (1). Similar to self-myofascial release techniques, the isolation of fascia prior to a load may help to facilitate mobility of a loaded muscle placed on stretch. Future research may look to investigate mobility outcomes from targeted treatment interventions, such as, myofascial release techniques compared to GT with and without mobility training.

The correlations of our data for the NWt-DF and Wt-DF (.242) of talocrural ROM is not significant and has a low correlation. However, Wt-DF and F-cm (.542) have a moderate significance correlation. Although the explained variance is relatively low between Wt-DF and F-cm measures ($r = .30$) it appears that the Wt-DF and F-cm is measuring something slightly different than the NWt-DF measure. There is a significant correlation, both the NWt-DF and Wt-DF measures appear to be clinically appropriate when assessing talocrural joint dorsiflexion. TS and GT effect size are relatively equal for Wt-DF and F-cm. It seems that GT does not have any more of an effect on talocrural dorsiflexion when compared to a typical TS protocol.

**Limitations and Clinical Implications**

There are several limitations regarding scientific outcomes and healthy muscle. In our study there was a high volume of manual treatment interventions and the excessive data collection performed by a sole investigator. This made treatment sessions long and exhausting for the clinician and may have affected the consistency of each patient’s GT treatment. Due to limited reports suggesting optimal number of treatment sessions and their duration, we had
minimal evidence other than comparative manual therapy protocols to base our 10 minute treatment, 2 days a week for 3 weeks. Further studies are warranted in this area. Another potential reason the GT group had statistical improvement in ROM, when compared to C and TS, is measurement error. The most experienced clinicians are subject to 3-5 degrees of error when using a goniometer (4). Since our improvements of Wt-DF for GT were only 2.5 degrees when compared to the C and 1.4 degrees with TS we cannot be certain that error did not occur. Also, the current study only examined a short term intervention period. Future studies should be conducted to see if there is not only an acute effect from the treatment but a chronic one as well.

A majority of the literature has reported promising outcomes from GT for pain and function for pathologic patients. However, the supporting literature consists of studies of with small populations and case controls and not randomized control trials. Many studies have low statistical power making the results from previous literature inconclusive for clinical practice (2, 14, 17). In addition, much of the literature focuses on pathological conditions. The current study is the first randomized control trial evaluating GT on healthy populations. The outcomes of the current study parallels previous literature on pathologic patients. Therefore, it can be surmised that the clinical efficacy of GT performed on a larger scale of pathologic patients will have similar outcomes. It was hypothesized that it would increase ROM at the talocrural joint and this study succeeded with significant results.

CONCLUSION

In conclusion, it appears a GT protocol of IASTM and endurance active ROM has better effect than a traditional stretching program for improving talocrural dorsiflexion ROM in healthy subjects. GT or IASTM provides additional mobility of fascia that stretching cannot achieve and improves range of motion more significantly, particularly when weight bearing. We understand
that GT is a time consuming treatment but based on our results it will aid or enhance a stretching protocol to improve range of motion and therefore decrease chance of injury.
Table 1: Subject Demographics (mean ± standard deviation)

<table>
<thead>
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<th>N</th>
<th>Sex (F, M)</th>
<th>Ht cm Mean± SD</th>
<th>Wt Kg Mean± SD</th>
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<tr>
<td>TS</td>
<td>14</td>
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<td>176.3 ± 8.6</td>
<td>80.1 ± 13.8</td>
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<tr>
<td>GT</td>
<td>19</td>
<td>(9, 10)</td>
<td>179.2 ± 9</td>
<td>74.1 ± 12.3</td>
</tr>
<tr>
<td>C</td>
<td>17</td>
<td>(8, 9)</td>
<td>168.2 ± 8.2</td>
<td>73.1 ± 11.2</td>
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<tr>
<td>Total/ Average</td>
<td>50</td>
<td>(29, 21)</td>
<td>177.57 ± 8.34</td>
<td>72.5 ± 13.19</td>
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TS= Traditional Stretch Group  
GT= Graston Treatment Group  
C= Control Group  
N= Number of participants per group  
Ht.= Average height per group participants in centimeters  
Wt.= Average weight per group participants in kilograms  
Age= Average age per group participants in years  
Sex =F- females, M- males
Table 2: Cohn’s $d$ Treatment Effect Size, Confidence Intervals and Percent Change from Pre- to Post-Intervention Between Groups for Dependent Variables

<table>
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<th>95% Confidence Interval</th>
<th>% Change Pre- to Post-Intervention</th>
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<tr>
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<tr>
<td>NWt-DF</td>
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<td>C=</td>
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<td>TS= NWt-DF</td>
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<td>GT= .9*</td>
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<td>C= -.6</td>
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<td>TS= Wt-DF</td>
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<td>C= .01</td>
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</table>

TS= Traditional Stretch Group
GT= Graston Treatment Group
C= Control Group
N= Number of participants per group
Nwt-DF= Non weight bearing prone dorsiflexion
Wt-DF= Close kinetic chain weight bearing knee to wall degrees of dorsiflexion at the talocrural joint
F-cm= Close kinetic chain weight bearing knee to wall centimeters of the foot to the wall
*= Indicates large Effect.
#= Indicates Moderate Effect.
Table 3: Dependent Variable Means, Standard Deviations, and the Change Score Group per Intervention Group

<table>
<thead>
<tr>
<th>Groups</th>
<th>N</th>
<th>Nwt-DF Pre-test (degrees) Mean± SD</th>
<th>Nwt-DF Post-test (degrees) Mean± SD</th>
<th>Wt-DF Pre-test (degrees) Mean± SD</th>
<th>Wt-DF Post-test (degrees) Mean± SD</th>
<th>F-cm Pre-test (cm) Mean± SD</th>
<th>F-cm Post-test (cm) Mean± SD</th>
<th>Change Score Nwt-DF (degrees) Wt-DF (degrees) F-cm (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TS</td>
<td>14</td>
<td>16.3 ± 7.2</td>
<td>18.1 ± 7.7</td>
<td>26.5 ± 6.2</td>
<td>27.8 ± 3.3</td>
<td>10 ± 3.0</td>
<td>11.2 ± 3.4</td>
<td>1.9 ± .5</td>
</tr>
<tr>
<td>GT</td>
<td>19</td>
<td>17.8 ± 7.0</td>
<td>19.8 ± 7.4</td>
<td>27.6 ± 3.8</td>
<td>30.4 ± 5.4</td>
<td>9.4 ± 3.3</td>
<td>11.1 ± 3.8</td>
<td>2.0 ± .4</td>
</tr>
<tr>
<td>C</td>
<td>17</td>
<td>18.3 ± 7.2</td>
<td>16.5 ± 7.3</td>
<td>23.5 ± 8.4</td>
<td>23.9 ± 8.7</td>
<td>8.8 ± 3.1</td>
<td>8.6 ± 3.2</td>
<td>-2.8 ± .1</td>
</tr>
</tbody>
</table>

TS = Traditional Stretch Group  
GT = Graston Treatment Group  
C = Control Group  
N = Number of participants per group  
Nwt-DF = Non weight bearing prone dorsiflexion  
Wt-DF = Close kinetic chain weight bearing knee to wall degrees of dorsiflexion at the talocrural joint  
F-cm = Close kinetic chain weight bearing knee to wall centimeters of the foot to the wall
Table 4: Interclass correlation coefficient (ICC) and level of statistical significance (p≤ .05) for Dependent Variables at Post-Intervention

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>NWt-DF</th>
<th>Wt-DF</th>
<th>F-cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>NWt-DF</td>
<td>1</td>
<td>.242 (.09)</td>
<td>.379 (.007)*</td>
</tr>
<tr>
<td>Wt-DF</td>
<td>1</td>
<td>.542 (.0001)*</td>
<td></td>
</tr>
<tr>
<td>F-cm</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

NWt-DF= None weight bearing prone dorsiflexion
Wt-DF= Close kinetic chain weight bearing knee to wall degrees of dorsiflexion at the talocrural joint
F-cm= Close kinetic chain weight bearing knee to wall centimeters of the foot to the wall
* = Indicates significant correlation at (.01 level) 2 tailed
BIBLIOGRAPHY


