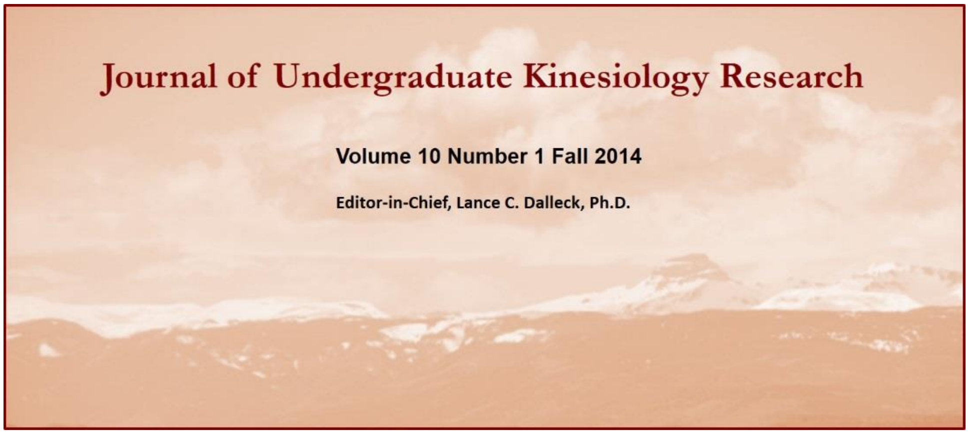

GRASTON TECHNIQUE ON SHOULDER MOTION IN OVERHEAD ATHLETES

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ABSTRACT

Heinecke ML, Thuesen ST, Stow RC. Graston Technique On Shoulder Motion In Overhead Athletes. *Journal of Undergraduate Kinesiology Research 2014*; (10)1:27-39. **Purpose:** Athletes with decreased shoulder motion are at a greater risk of injury. Graston Technique (GT) has been found effective in treating soft tissue limitations; however, GT has not been researched along with a dynamic stretching and strengthening protocol. The purpose of this study was to determine the effect GT has on improving shoulder motion compared to a stretching and strengthening protocol in overhead athletes. **Methods:** Fourteen athletes (eight women and six men) were included. Volunteers were participating in university sports of softball, baseball, or volleyball, and had no history of a shoulder injury in the past six months or no shoulder surgeries within a year. Measurements were taken at baseline, mid-point, and at the conclusion of the four-week study. Using a goniometer, external rotation, internal rotation, and horizontal adduction of both shoulders was recorded. Apley's Scratch test was utilized to assess mobility of both shoulders in three different positions, using a measuring tape to record the distance reached from a certain landmark. Data analysis was completed using repeated measures factorial ANOVA. **Results:** There were significant differences noted in the time factors from beginning to midpoint measurements with right internal rotation [$t(13)=-2.80$, $p=.015$], left horizontal adduction [$p<.001$], and Apley's right under the shoulder [$p< .001$]. Likewise, significant time differences were found from beginning to final measurements with right external rotation [$t(13)=-2.81$], right horizontal adduction [$p=.008$], left horizontal adduction [$p=.010$], and Apley's right under the shoulder [$p=.011$]. Finally, significant time differences were noted from midpoint to final measurements with right horizontal adduction [$p=.001$] and left horizontal adduction [$p< .001$]. There was also a significant relationship found when comparing the GT and control groups during Apley's left under the shoulder [$F(1,12)=5.02$, $p=.045$]. Averages for the GT at baseline (-5.03 ± 5.43), midpoint

(-6.04±2.30), and end (-5.24±3.51) were compared to the control group averages at baseline (-10.17±4.89), midpoint (-10.19±4.62), and end (-9.74±5.01). **Conclusion:** The results of the study suggest GT may help prevent greater loss in shoulder motion that is a byproduct of the dynamic stretching and strengthening protocol, although the GT protocol should be revisited to maximize group differences.

Key Words: Mobility, Range-of-Motion, Instrument Assisted Soft Tissue Mobilization, Thera-Bands, Dynamic

INTRODUCTION

With an estimated 42% of all college baseball injuries occurring from non-contact mechanisms, including throwing or running, and similar trends noted in softball players, overhead athletes are shown to be at an increased risk for developing shoulder problems such as strains, tendinitis, or subluxations (1,2). Large amounts of biomechanical forces are placed on the shoulder during sporting activity, causing alterations in the soft tissue around the glenohumeral joint, most frequently documented in the internal and external rotating muscles (3,4).

A common complaint from individuals with these soft tissue adaptations is glenohumeral internal rotation deficit, also known as GIRD (5). Literature has found a greater risk of injury in athletes with preexisting GIRD, demonstrating the importance in preventing future cases of and treating individuals currently experiencing GIRD (4,5).

Efforts to explain the specific cause of GIRD have provided a few hypotheses. One such study by Laudner et al. (2012) described thickening and scarring of shoulder tissue as a result of repetitive eccentric loading on the posterior shoulder, especially during overhead activities (6). Additional research by Lintner et al. (2007) mentions total shoulder arc-of-motion, the amount of internal and external rotation (ER) added together, stays the same in all individuals, but those experiencing GIRD show an external shift of the shoulder leading to greater ER and diminished internal rotation (IR) (5). The study further elaborates that an external shift of the shoulder may lead to anterior instability, possibly predisposing the individual to future shoulder injuries, both acute and chronic in nature (muscle strain, shoulder dislocation, impingement, etc.). Anterior instability can be especially problematic in overhead athletes, as they require repetitive deceleration of the unstable arm (7).

Current ideology for improving shoulder IR involves warming up shoulder musculature through light exercise or thermal modality followed by static stretching. Studies by Harshbager et al. (2013) along with Laudner et al. focused on static stretching in order to improve horizontal adduction (HZ ADD) and IR, and found improvements in participant’s range-of-motion (ROM) after a single treatment when comparing pre-intervention and post-intervention measurements (8,9).

An approach gaining popularity over the past years is the combination of Graston Technique (GT) with a stretching protocol. GT is a form of instrument assisted soft tissue mobilization intended to treat soft tissue restrictions through inducing a healing response by the body (9). The same study speculated that GT's use of cross-friction massage in the tissue produces microtrauma, stimulating blood flow to heal the treated area. While GT is becoming more commonly implemented in the clinical settings, there is still much to learn about the effects of GT and application protocols, especially related to improving shoulder mobility.

Similar in the limited amount of evidence available about the effectiveness of GT, dynamic stretching and strengthening protocols are also not properly understood in comparison to static programs. In order to progress shoulder rehabilitation ideology and ROM improvement practices, further investigation is warranted on the combined effect of GT and dynamic programs on shoulder mobility, especially in populations such as overhead athletes, at higher risk of developing shoulder injuries or GIRD.

The purpose of this study was to determine if overhead athletes at a university in the Midwestern United States receiving a combination of GT and a dynamic stretching/strengthening program would show greater improvements in shoulder ROM when compared with overhead athletes at the same institution who solely completed the dynamic stretching/strengthening program over a four-week period. It was hypothesized that the treatment group would demonstrate greater ROM and shoulder mobility improvements than the control group.

METHODS

Subjects

In this study, university students between the ages of 18 and 22 who participate in the overhead activities of softball, baseball, and volleyball were included. Participants were excluded if they experienced shoulder injury within the past 6 months or underwent shoulder surgery within the past year. Members of each overhead sport (softball, club baseball, men's club volleyball, and women's club volleyball) were contacted via email. A total of one hundred-twenty two individuals were recruited between the four sports, with fifteen volunteering. The lone men's club volleyball volunteer lost contact with the study and was unable to participate. Thirteen of the fourteen participants reported to be right arm dominant during sporting activity. After preliminary screening, no participants were excluded based on the stated guidelines.

All eligible participants were stratified based on gender and then randomly assigned to the control or treatment group using a random number generator website. Seven participants (four females and three males) were placed in the control group while seven participants (four females and three males) were placed in the treatment group. Table 1 shows group means and standard deviations for age and duration of sports participation. This study received an approval from the Intuitional Review Board, and all participants signed the informed consent prior to baseline testing.

Table 1. Participant characteristics. Values are reported in means ± standard deviations.

	Sex	Age (years)	Sport Participation (years)
Treatment	Male (*n*=3)	19.70 ± 0.58	13.33 ± 2.89
	Female (*n*=4)	20.00 ± 0.82	11.50 ± 3.32
Control	Male (*n*=3)	20.00 ± 2.00	14.00 ± 3.46
	Female (*n*=4)	19.00 ± 0.82	11.00 ± 1.83

Instrumentation

Goniometry. The first method used to assess the effectiveness of GT on glenohumeral ROM was measured with a Patterson Medical Holdings, Inc. (Bolingbrook, IL) goniometer, product number 7514. According to Mullaney et al. (2010), reliability of such measurements were found to be between .71-.98, while Kolber and Hanney (2012) found the validity to be greater than .85 (10, 11). These measures were found to be effective for discerning changes in ROM over time and are most accurate when one individual completes all measurements.

Apley's Scratch Test. Apley's Scratch Test has also been used in previous studies, including research completed by Bodin et al. and Beard (12,13). Dewhurst and Bampouras (2014) found the reliability of the Apley's Scratch Test for assessing shoulder mobility to be greater than .8 (14). Using a tape measure from Patterson Medical Holdings Inc., data was collected in centimeters. Similarly to goniometer measurements, the Apley's Scratch Test has been found to be most accurate with one individual completing all measurements.

*Graston Technique***.** GT was invented by a former athlete after conventional rehabilitation techniques were ineffective in treating his knee injury. Collaborating with a health professional, the GT team designed six instruments to be administered in different parts of the body. Three GT instruments were used throughout our study; specifically the instruments GT2, GT3, and GT4 (Figure 1).

Figure 1. Graston technique instruments: GT4 (left), GT3 (middle), and GT2 (right).

*Thera-Band**.*** The dynamic stretching and strengthening program was completed using Thera-Bands (Akron, OH). Starting at a resistance level of 3.0 pounds during 100% band elongation, participants progressed from the yellow to the red band, which offered 3.7 pounds. From there, green with a resistance of 4.6 pounds was utilized, followed by blue, with 5.8 pounds of resistance, and finally black, with 7.3 pounds of resistance (http://www.thera-band.com/userfiles/file/thera-band_instruction_manual_v5.pdf).

Procedures

Prior to randomization of participants, baseline measurements were conducted on all participants. Measurements included bilateral ER, IR, and HZ ADD of the glenohumeral joints with a goniometer, based on the literature published by Starkey et al. (15). This was followed by the Apley's Scratch Test with three different positions: 1) over the head reaching for the inferior angle of the same side scapula; 2) behind the back reaching for the inferior angle of the opposite side scapula; and 3) across the chest and around the arm reaching for the opposite side medial scapular border. Measurements were taken for each based on the distance from the middle finger to the stated landmark. An average of three trials was computed bilaterally for each for each motion. This protocol was repeated 2 weeks into the intervention and following the completion of a four-week treatment. Goniometer and Apley's Scratch Test measurements were taken by the same person throughout the study to ensure consistency with the data.

After randomization of the participants into groups (i.e., treatment and control), the interventions commenced. Participants in the control group began with a 3-minute upper body ergometer warm-up with the resistance level based on perceived exertion high enough to properly prepare for the dynamic exercises without over-fatiguing themselves. Directly after warm-up, participants moved to the dynamic stretching and strengthening program. The Thera-Band was positioned in the highest slot of the wall bracket during ER stretching. As shown in Figure 2, the arm was held at 90° shoulder abduction, 90° elbow flexion, and maximal shoulder ER, while maintaining upright posture. The participant was a distance from the wall sufficient enough to provide a stretch without overstraining the shoulder. The stretch was maintained for 10 seconds followed by resisted glenohumeral IR (with the shoulder maintaining proper position), which constituted one repetition. This was repeated for 2 sets of 8 repetitions for each arm. Next, the Thera-Band was placed in the lowest slot of the wall bracket in order to provide a proper IR stretch. Posture remained the same as with the previous exercise, however, the shoulder was placed in maximal IR, as shown in Figure 3. The stretch was maintained for 10 seconds followed by resisted glenohumeral external rotation. This was repeated for 2 sets of 8 repetitions for each arm.

Figure 2. External rotation. *Left*: Starting position, held for 10 seconds. *Right*: Ending position.

Figure 3. Internal rotation. *Left*: Starting position, held for 10 seconds. *Right*: Ending position.

Treatment group participants began with the same warm-up routine as the control group. After completion of the warm-up, the patient was placed in a prone position with both shoulders exposed. With the arm of the shoulder receiving treatment at the patient's side, instrument GT4 was used in the infraspinatous fossa for 30 seconds followed by 30 seconds in the supraspinatous fossa. GT3 was used next for 30 seconds in the infraspinous fossa, 30 seconds in the supraspinous fossa, and 30 seconds along the medial border of the scapula. Finally, GT2 was used around the scapular borders for 45 seconds. Both arms were completed consecutively, with the left arm receiving treatment first. GT was administered by a researcher trained in the ideology and application of treatment. Directly following GT treatment, the dynamic stretching and strengthening protocol was completed the same as control group, with the left arm going first.

Control and treatment groups completed the stated procedures twice a week over four consecutive weeks. Participants were given two days between the first treatment and second treatment of each week.

Thera-Band progression was based on each participant maintaining proper form during all repetitions and sets of the exercise. Proper technique was described as the participant maintaining upright posture, shoulders and elbows maintaining the previously described positioning, and completing smooth IR and ER movements. Table 2 displays Thera-Band progression based on Thera-Band's stated resistance level (http://www.thera-band.com/userfiles/file/thera-band_instruction_manual_v5.pdf). Progression decision was made by the researcher observing the participant's proper technique during the entire exercise.

Table 2. Thera-Band progression with proper form.

Progression	Set 1	Set 2
1	Yellow Band	Yellow Band
2	Yellow Band	Red Band
3	Red Band	Red Band
4	Red Band	Green Band
5	Green Band	Green Band
6	Green Band	Blue Band
7	Blue Band	Blue Band
8	Blue Band	Black Band

Statistical Analyses

The study was completed with a pre-test/post-test randomized-group design. The main independent variable was the treatment, while shoulder ROM and mobility were dependent variables. Data analysis was completed using a repeated measures factorial ANOVA with IBM SPSS version 19.0 and a significance level of α=.05.

RESULTS

Descriptive statistics for means and standard deviations of dependent variables by group and time are presented in Table 3. Using α=.05, the two-way repeated measures ANOVA indicated time effects for right IR and ER, right and left HZ ADD, and right Apley's under the shoulder (all $p < .05$). Paired-samples t-tests (using a Bonferroni-adjusted α=.0167) as multiple comparisons of these dependent variables indicated there were increases in right IR, left HZ ADD, and right Apley's under the shoulder from beginning to midpoint. Significant improvements were also seen from midpoint to final in right and left HZ ADD. Overall, right IR, left HZ ADD, and right Apley's under the shoulder significantly improved from beginning to final (Tables 4 and 5). No significant group effects were seen in any dependent variables, except left Apley's under the shoulder (Table 4).

Table 3. Goniometry and Apley's Scratch data by group and time (n=14). Values are reported in means ± standard deviations. Abbreviations: IR = internal rotation; ER = external rotation; HzAdd = horizontal adduction; "Over", "Under", and "Across" are measurements of Apley's Scratch Test (negative values indicate greater mobility).

		Beginning	Midpoint	End
IR Right	Total	50.65 ± 16.81	60.02 ± 11.43	55.38 ± 10.35
	GT	50.96 ± 13.33	56.76 ± 12.75	57.09 ± 8.08
	Control	50.34 ± 20.84	63.29 ± 9.80	53.67 ± 12.64
IR Left	Total	57.10 ± 11.30	61.48 ± 8.60	60.21 ± 5.85
	GT	54.49 ± 11.29	60.27 ± 9.40	61.01 ± 4.83
	Control	59.71 ± 11.53	62.69 ± 8.28	59.40 ± 7.01
ER Right	Total	102.15 ± 8.52	105.89 ± 12.96	108.14 ± 11.03
	GT	98.61 ± 6.69	100.93 ± 10.74	103.94 ± 8.69
	Control	105.69 ± 9.12	110.84 ± 13.83	112.34 ± 12.11
ER Left	Total	98.12 ± 7.94	100.70 ± 9.57	104.14 ± 10.89
	GT	96.77 ± 8.55	99.61 ± 9.99	103.64 ± 9.32
	Control	99.47 ± 7.70	101.79 ± 9.79	104.63 ± 13.02
HZ ADD Right	Total	111.96 ± 20.99	126.46 ± 8.97	132.77 ± 10.95
	GT	101.30 ± 24.73	125.63 ± 12.75	131.77 ± 14.71
	Control	122.63 ± 8.79	127.29 ± 3.16	133.77 ± 6.42
HZ ADD Left	Total	114.56 ± 19.44	125.73 ± 8.66	134.31 ± 8.93
	GT	105.69 ± 24.43	127.46 ± 10.58	135.90 ± 10.02
	Control	123.44 ± 6.12	129.00 ± 5.07	132.71 ± 8.16
Over Right	Total	11.28 ± 2.95	12.81 ± 2.27	13.19 ± 2.26
	GT	12.87 ± 3.05	13.01 ± 2.88	13.94 ± 2.41
	Control	9.69 ± 1.89	12.61 ± 1.68	12.43 ± 1.97
Over Left	Total	10.81 ± 3.09	12.14 ± 2.59	12.01 ± 2.56
	GT	11.61 ± 3.63	12.87 ± 2.86	12.26 ± 3.19
	Control	10.00 ± 2.44	11.41 ± 2.27	11.77 ± 1.97
Under Right	Total	-4.91 ± 4.46	-4.89 ± 4.20	-5.51 ± 4.47
	GT	-4.63 ± 4.83	-4.07 ± 4.19	-4.77 ± 4.52
	Control	-5.19 ± 4.43	-5.71 ± 4.38	-6.24 ± 4.64
Under Left	Total	-7.60 ± 5.64	-8.11 ± 4.12	-7.49 ± 4.77
	GT	-5.03 ± 5.43	-6.04 ± 2.30	-5.24 ± 3.51
	Control	-10.17 ± 4.89	-10.19 ± 4.62	-9.74 ± 5.01
Across Right	Total	4.85 ± 4.61	5.44 ± 5.42	4.75 ± 5.70
	GT	7.34 ± 4.53	7.90 ± 6.22	6.73 ± 6.26
	Control	2.36 ± 3.32	2.87 ± 3.28	2.77 ± 4.71
Across Left	Total	5.60 ± 6.21	4.81 ± 5.64	4.34 ± 4.26
	GT	8.96 ± 6.43	7.27 ± 5.83	6.11 ± 3.34
	Control	2.24 ± 3.98	2.36 ± 4.58	2.57 ± 4.56

Table 4. Results of two-way repeated measures ANOVA (*n*=14). Values are reported in means ± standard deviations. Abbreviations: IR = internal rotation; ER = external rotation; HzAdd = horizontal adduction; "Over", "Under", and "Across" are measurements of Apley's Scratch Test (negative values indicate greater mobility).

		F	**df nominator**	**df denominator**	**MSE**	***p***	**Partial eta^2**
IR Right	Time	5.17	2.0	23.5	60.700	.014	.301
	Group	.02	1.0	12.0	7.292	.898	.001
	Interaction	1.55	2.0	23.5	60.700	.234	.114
IR Left	Time	1.862	1.8	21.7	42.116	.182	.134
	Group	.251	1.0	12.0	42.401	.625	.021
	Interaction	1.085	1.8	21.7	42.116	.350	.083
ER Right	Time	8.829	1.6	18.6	18.742	.004	.424
	Group	2.512	1.0	12.0	751.840	.139	.173
	Interaction	.488	1.56	18.6	18.742	.575	.039
ER Left	Time	8.063	1.9	22.2	17.084	.003	.402
	Group	.154	1.0	12.0	40.024	.702	.013
	Interaction	.171	1.9	22.2	17.084	.828	.014
HZ ADD Right	Time	8.303	1.2	14.4	319.833	.009	.409
	Group	4.144	1.0	12.0	728.334	.064	.257
	Interaction	2.312	1.2	14.4	319.833	.148	.162
HZ ADD Left	Time	8.181	1.1	13.7	293.280	.011	.405
	Group	3.880	1.0	12.0	520.115	.072	.244
	Interaction	2.292	1.1	13.7	293.280	.151	.160
Over Right	Time	7.139	1.7	21.2	2.274	.006	.373
	Group	2.362	1.0	12.0	30.345	.150	.164
	Interaction	3.432	1.8	21.2	2.274	.056	.222
Over Left	Time	2.834	2.0	23.7	2.714	.079	.191
	Group	.825	1.0	12.0	14.762	.382	.064
	Interaction	.488	2.0	23.7	2.714	.618	.039
Under Right	Time	2.328	2.0	23.9	0.741	.119	.162
	Group	.265	1.0	12.0	15.726	.616	.022
	Interaction	1.613	2.0	23.9	0.741	.220	.188
Under Left	Time	.212	1.9	22.5	7.777	.797	.017
	Group	5.017	1.0	12.0	221.720	.045	.295
	Interaction	.123	1.9	22.5	7.777	.873	.010
Across Right	Time	.380	2.0	24.0	5.050	.688	.031
	Group	3.674	1.0	12.0	224.486	.079	.234
	Interaction	.232	2.0	24.0	5.050	.795	.019
Across Left	Time	.380	2.0	24.0	5.050	.688	.031
	Group	3.674	1.0	12.0	224.486	.079	.234
	Interaction	.232	2.0	24.0	5.050	.795	.019

Table 5. Results from selected multiple comparisons. Paired sample *t* tests were run with α=.0167. Abbreviations: IR = internal rotation; ER = external rotation; HZ ADD = horizontal adduction; "Over" is a measurement of Apley's Scratch test.

	Time Point Comparison	t	*p*
Right IR	Beginning-Midpoint	-2.80	.015
	Beginning-Final	-1.53	.150
	Midpoint-Final	1.92	.077
Right ER	Beginning-Midpoint	-2.11	.055
	Beginning-Final	-4.06	.001
	Midpoint-Final	-2.74	.017
Left ER	Beginning-Midpoint	-2.53	.025
	Beginning-Final	-.90	.383
	Midpoint-Final	-2.31	.038
Right HZ ADD	Beginning-Midpoint	-2.17	.049
	Beginning-Final	-3.13	.008
	Midpoint-Final	-4.55	.001
Left HZ ADD	Beginning-Midpoint	-1.92	.077
	Beginning-Final	-3.03	.010
	Midpoint-Final	-5.21	.000
Right Over	Beginning-Midpoint	-16.30	.000
	Beginning-Final	-2.94	.011
	Midpoint-Final	-1.02	.325

DISCUSSION

Dynamic Thera-Band exercises are a common warm-up and strengthening techniques for overhead athletes as these are thought to decrease an individual's risk of injury and help recover from natural wear and tear associated with the sport, but minimal data is available on its effect on shoulder movement (16). Acutely, GT has been found to decrease pain and assist in regulating functional shoulder motion after injury (17). GT has gained popularity in improving soft tissue extensibility to improve motion in the structure, but the best combination of stretching, exercise, and GT for optimal long-term results has yet to be found. The results of our study provide insight into the effects of combining dynamic Thera-Band exercises with a brief GT treatment to the posterior shoulder twice a week over four weeks in order to improve glenohumeral ROM.

Progression of Dynamic Stretching and Strengthening Protocol

Both control and treatment groups experienced increases in goniometer measurements but larger Apley Scratch test scores, showing a greater distance from the bony landmark. When assessing the results of both groups, a possible explanation could be the Thera-Band progression used during the study. Early in the process, less resistive bands (yellow, red, and green) were utilized, while higher resistance bands (blue and black) were common at the end. It is speculated that the less resistive bands allowed more balance between stretching and strengthening the tissue, as less tensile force is provided, thus allowing mobility improvement or less tissue restriction to develop while also strengthening the rotator cuff muscles (16). Once individuals progressed to stronger bands, more emphasis was placed on strengthening, possibly resulting in less stretching and greater tissue restriction as the individuals progressed in shoulder strength. It would be of interest to measure the strength improvement of the internal as well as external rotators of the glenohumeral joint in future studies. Dynamic band exercises are seen as a good preparation tool for overhead athletes before or during the season in order to properly warm-up and decrease injury risks, but minimizing the motion restrictions that may result is an important goal (18).

Possible Benefits of Graston Technique

Though statistically insignificant, treatment group members were found to have larger increases in goniometer measurements and smaller losses in Apley's Scratch girdle mobility than control group members (Table 3). This may suggest that while it does not significantly improve shoulder motion, combining GT with a dynamic Thera-Band protocol may help prevent greater motion loss or lead to slightly larger improvements when compared with solely using the dynamic Thera-Band protocol.

Strengths and Limitations

Our study is the first to examine a prolonged GT program on the posterior shoulder tissues in combination with a dynamic shoulder program, whereas previous research has focused on single GT application along with static stretching (9). The authors acknowledge there were a few limitations during the study. With the dynamic exercises, participants were relied on to provide an adequate stretch based on personal perceptions, though what each individual believed to be adequate may have varied throughout the sessions or from one participant to the others. Additionally, between both groups, the stretching and strengthening protocol was not monitored by the same investigator, which may have led to discrepancies in progression, although attempts to minimize this were utilized through the set progression guidelines.

Improvements for Future Studies

Before GT's long-term impact can be assessed, further data should be collected comparing static and dynamic programs without the assistance of GT. Upon a greater understanding of each protocols influence on shoulder motion through a longer period of time, GT should be added in order to discover the ideal approach to maximize glenohumeral joint motion improvements. Additionally, GT is still not completely understood in terms of what protocol will best improve shoulder motion. Eight GT treatments over four weeks is recommended and has been used in previous studies, but future research should look at altering number of treatment to help determine the ideal number for providing best patient outcomes (19). Additionally, this study applied the specific GT instruments 2, 3, and 4 to treatment areas for the selected amount of time. Future studies should expand on the posterior shoulder treatment sites, GT instruments utilized, and strokes employed to better understand the tissue's response after each methodological alteration and the resulting change in shoulder motion.

CONCLUSIONS

In this study, both groups demonstrated increases in goniometer measurements and worse Apley's Scratch girdle mobility from pre to post study. These data may suggest that the GT protocol should be revisited to maximize group difference and be compared to other treatment modalities to preserve shoulder mobility while improving glenohumeral ROM.

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