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Effect of Graston Technique on Functional Abilities in Chronic Supraspinatus Tendinopathy

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Abstract:
Purpose: To evaluate the impact of Graston technique on functional abilities and pain intensity in competitive swimmers with chronic supraspinatus tendinopathy.
Methods: Forty participants were enrolled from the Outpatient clinic of Al-Ahly Sporting Club, both genders were randomized into two groups of equal number after assigned consent forms; Group A: had received the Graston technique over the myofascial fascia of the trapezius upper fibers, plus traditional physiotherapy program. While group B: had received a traditional physiotherapy program, only. The study protocol consists of 45 minutes repeated three sessions a week for four weeks. All participants` data regarding the Arabic version of the Disabilities of Arm, Shoulder, and Hand Questionnaire (DASH) and Visual Analogue Scale (VAS), at the study baseline and by study protocol end, were tabulated and then statistically analysed.
Results: The findings revealed statistical substantial differences among groups concerning DASH and pain intensity (P<0.05) to word the study group.
Conclusion: Adding the Graston technique to conventional therapy is an effective therapeutic modality to improve functional abilities and decrease pain intensity in competitive swimmers with chronic supraspinatus tendinopathy.
Key words: Supraspinatus, Tendinopathy, Swimmer, Graston, Function, Pain, Shoulder.

1.Introduction:

Swimming is a very technical sport and highly skilled activity that requires different shoulder movements during the propulsive phases of all strokes. Competitive swimmers swim often approximately 42 to 110 thousand meters per week depending on the competitive level, this could equate to an average of 16.8- 44 thousand rotations of each shoulder every week. Almost, shoulder pain forces 10- 31% of swimmers to stop training for some time. A significant percentage of chronic shoulder injuries were sometimes career-ending (1).

The term "Swimmers' Shoulder" refers to a variety of consecutive or co - occurring pathologies, the most prevalent among which is rotator cuff-pain. This is thought to be due to repetitive stress causing impingement of the supraspinatus as well as biceps tendons, which account for 90% of all shoulder injuries (2). Shoulder pain in elite swimmers; primarily due to swim-volume-induced supraspinatus tendinopathy that typically could be extended from three to six months, even whole a year to cure (3).

Chronic supraspinatus tendinopathies among competitive swimmers lead to scar development that might result in a serious complete rotator cuff

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or labral tear. Furthermore, earlier in the current century Yanai and Hay had reported that with 24.8% of freestyle strokes experiencing dynamic impingement syndromes, the rotator cuff directly below to the coracoacromial arch is at a high risk of injury. Impingement represents 24.8% of freestyle strokes (4).

Although a singular accepted treatment for supraspinatus tendinopathy has not been agreed upon, treatment solutions are traditionally Ultrasound and deep friction massage, which have a little edge over therapeutic ultrasound; such interventions are effective in managing the supraspinatus tendinitis and show a gradual improvement in symptoms of supraspinatus tendinitis over a period of 10 days (5).

The Graston technique is a form of soft tissue mobilisation that is considered to offer a mechanical advantage for the practitioner by permitting deeper penetration and also specific treatment, lowering the prescribed stress on clinicians' hands, and rising the perception of vibration, all of which may improve the clinician's capability to recognize changed tissue properties (e.g., recognize tissue adhesions) as well as the patient's awareness of changed sensations (6).

Graston technique could produce positive changes in soft tissue functional recovery after tendon injury through refinement that occurs as Graston technique induces underlying structures micro-trauma, resulting in regional inflammation, thus optimizing fibroblast release and migration, and inducing collagen synthesis, as well as accelerating tissues' regeneration and in the same line tissues oxygenation, and facilitating removal of local waste metabolites (7).

To available data, there is a lack of research showing the effect of Graston technique in competitive swimmers with chronic supraspinatus tendinopathy, which costs nearly seven billion per year. [8] There is some debate over whether physical treatment helps swimmers suffering supraspinatus tendinopathy regain full soft-tissue function after the injury. This study was conducted to see how treating swimmers' supraspinatus tendinopathy with the Graston treatment having affected their functional abilities as well as pain intensity.

2.Patients and Methods:

2.1. Study design:

This study was designed as a prospective pre-test/post-test randomized controlled clinical trial.

The procedures of the current study were carefully reviewed, and all patients were required to sign a written informed consent following receiving approval from the ethics committee of the Faculty of Physical Therapy, Cairo University- Egypt (P.T.REC/012/003032).

Based on the findings of the pilot study and the G-Power program, the recommended sample size was 40 patients, with 20 patients in each group, and the P value was adjusted at 0.05, the power was at 0.95, and the effect size was 0.458.

2.2. Participants:

Sixty-two competitive swimmers with chronic supraspinatus tendinopathy, who had experienced pain for at least three months prior; were enrolled from the clinic of the Al-Ahly Sporting Club (Zayed branch), through a flyer as a method for recruitment during the period of March 2020 to March 2021. Participants were randomly assigned into two equal groups as represented in flow chart **(Figure 1)**; **Group A:** had received Graston technique over myofascial fascia of upper fibers of trapezius, plus a traditional physiotherapy program. Treatment protocol was given for 45 minutes /3 times/week for 4 weeks for a total of twelve sessions. **Group B:** had received a traditional physiotherapy program only. The participants were assigned into 2 groups of equal number (n=20) using the numbers written on index cards and stored in sealed, opaque envelopes. A researcher who was also blinded opened the sealed envelope and randomly assigned the participants to one of two groups.

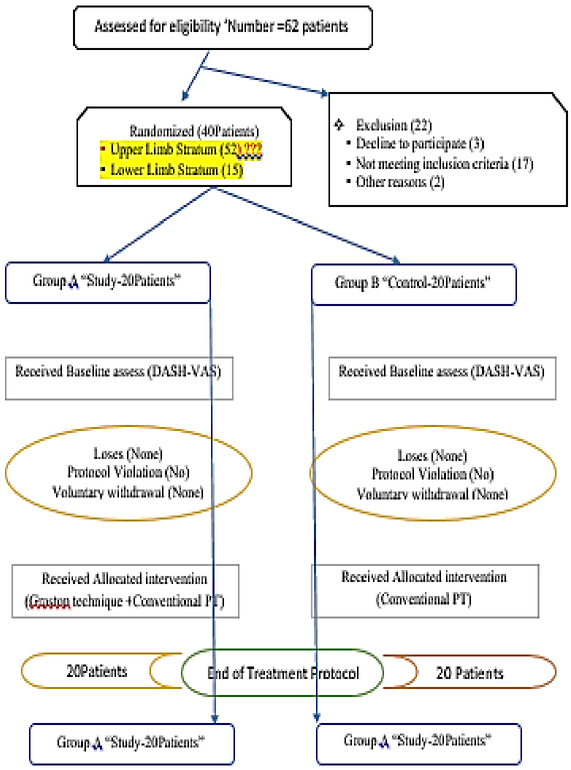

Figure (1): Flow diagram of the study.

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Inclusion Criteria: Age (18-32 years old), both genders as well normal BMI (20-30Kg/m^2), chronic supraspinatus tendinopathy, referred by a physician who had to experience pain for at least 3 months, positive empty can test, suggesting probable engagement of the supraspinatus, professional elite swimmers who trained at least 3 days per week covering 40k (7,8). **Exclusion Criteria:** Swimmers underwent other physical therapy programs in the last three months, intra-articular steroid injection, fracture of the shoulder girdle, shoulder joint dislocation or subluxation, any cervical surgery, breast cancer, infection medications that affect pain perception as NSAID, malignancy, X-ray therapy, hypertension, dyslipidemias, renal failure, myocardial infarction, myasthenia gravis, cerebral microangiopathy detected in magnetic resonance imaging , ophthalmoscopy findings, hyperthyroidism, hemorrhage, acute viral pathological, acute tuberculosis, mental problems , or cardiac pacemakers (7,8).

2.3. Instrumentation:

2.3.1. Measurement equipment and tools:

***2.3.1.1.* Arabic version of Disabilities of arm, shoulder, and hand questionnaire (DASH):**

The Disability, Activity, and Participation in Daily Life (DASH) questionnaire can be used to measure the severity of impairments, classify different types of disabilities, and track the development of symptoms and levels of functioning through time. A person's overall functional capacity (across 21 items) is evaluated, regardless of whether they are adjusting with the opposite limb. Several studies have confirmed the validity and reliability of this DASH questionnaire version.9 Every patient was given a 4-point scale from mild (1 point), moderate (2 points), severe (3 points), and very severe (4 points) to rate the severity of their symptoms (9).

***2.3.1.2.* Visual Analogue scale:**

It was widely utilized for measuring pain intensity, it is easy to understand and administer, and has excellent test-retest reliability.10 The VAS consists of a 100 mm transverse line with two polar labels attached to it; patients assign a score to the scale using a vertical line. Where patients were requested to select the number between 0 (no pain) and 10 (worst possible pain) that best-described intensity of pain felt (10).

2.3.2. Therapeutic equipment and tools:

2.3.2.1. Graston Technique Tool:

Myofascial Release Tools Set of 5 in Hard Aluminium Carry Case with Foam Padding. Made from medical grade 304. Corrosion resistant stainless-steel with a surgical finish. Weighs approximately 6 lbs/ 2.72 kg, carefully crafted double-level massage tools for use in both directions.[11]

2.3.2.2. Hot and Ice pack Gel:

Roscoe Reusable Cold Pack and Hot Pack; Microwave Heating Pad, 5 x 10 Inches made of durable, soft-touch material.[12]

2.3.2.3. Thera Band:

It is latex bands or tubes. It has color-coded bands. Those authenticated Thera Band Progressive Resistance Bands are a four-pack of 3-inch-wide, continuously looped elastic bands in the same colours and corresponding resistance levels.[13]

2.4. Procedures of the study:

The protocol was thoroughly explained to each patient then each participant had assigned a written consent form. Shoulder functional abilities using the Arabic version of the DASH Questionnaire and pain intensity using VAS were measured twice, once before and once after the study treatment protocol.

2.4.1. Measurement Procedures

2.4.1.1Functional ability assessment:

Functional ability was measured with DASH Questionnaire. Each patient was asked to read each question carefully and chose the response using a rating scale in which responses ranged from (0) no experience of the symptom, (1) mild, (2) moderate, (3) severe, and (4) very severe (9).

2.4.1.2 Pain assessment:

The shoulder pain intensity level was evaluated by using the numerical pain rating scale (NPRS) before and after the treatment. The patient will be asked to place a mark on his\her level of pain on a sheet of NPRS (11).

***2.4.2. Therapeutic Procedures*:**

Both groups A and B; patients received conventional physical therapy programs including Hot pack application, stretch exercises targeting the upper trapezius (14), the pectoralis minor (15), three repetitions of thirty seconds, and thirty seconds among repetitions conducted. Followed by strengthening exercises (8,13) for external shoulder rotators, lower trapezius, and serratus anterior, using 1-m color-coded elastic resistance bands (13) and 3 sets of 10 repetitions for each. Hot and cold packs (12) are gentle on the skin. Treatment was repeated three sessions a week for 4 weeks.

***2.4.2.1*Stretching exercises:**

These exercises were conducted for both groups. There was a total of three stretches done on the affected and unaffected sides as part of the therapeutic exercise program. For this program, we stretched the posterior shoulder, the pectoral minor, as well as the upper trapezius. Every stretch was done three times for a total of one minute and thirty seconds, with a ten minutes' rest in between each set (16).

2.4.2.1.1. Upper trapezius stretching:

By sitting in a straight position, with head and neck are in neutral position; the earlobes are in line with the shoulders, and the chin is tucked in slightly. Re-establishing the natural alignment of your head and neck by placing your left hand upon the right side of your head (14).

2.4.2.1.2. Pectoralis minor stretching:

By placing forearms and palms on either side of the wall at approximately shoulder level then Inhaling then Exhaling, and pulling lower abdominal muscles into the spine, lean toward the wall. Going to the point where it feels challenging but causes no pain or discomfort. Moving the whole body as a unit, not bending anywhere along the chain, and finally holding the position for between 5-30 seconds, then coming back to start (15,16).

***2.4.2.2.* Strengthening exercises**

After warming up with stretches, we strengthened our muscles using 1-m Therabands (The hygienic Corporation, Akron, OH) with varying degrees of resistance (as shown by the bands' colors) (red, green, or blue). The program consisted of three sets of ten repetitions for every movement, with one minute of resting in between. Whenever the individual reports feeling no muscle fatigue after completing the three sets, the resistance is raised by switching to a tighter elastic band. Shoulder lateral rotation, lower trapezius, as well as the serratus anterior muscle were performed (8,13).

***2.4.2.3.* Cryotherapy:**

By using the cold pack gel, the cold application lasts for 10 min (12,17).

***2.4.2.4.* Instrument Assisted Soft Tissue Mobilization:**

Patients in group A have received the Graston technique as follows; localized warming-up training for the shoulder region for 3-5minutes using a hot pack followed by applying the Graston technique as patients lay in the prone-lying position on a bed and Towels were positioned below the humerus after the patient performed the following sequence of shoulder abduction, elbow flexion (90 degrees), as well as neutral rotation. After that, an instrument was positioned at a 45 degree angle on the muscle and administered for about 20 seconds in a parallel direction to the muscle fibers,18 then switched to the perpendicular direction for a further 20 seconds, for a total of 40 seconds then apply stretching exercises for upper fibers of trapezius (14), pectoralis minor (15), plus posterior shoulder capsule followed by strengthening exercises[8] using one meter coded "red, green or blue" elastic resistance Thera band (13) for external rotators and serratus anterior then followed by cryotherapy (17) for ten minutes.

Data analysis:

The data collected in this study was analyzed using SPSS version 25. For each participant's height, weight, BMI, swimming type, swimming time, pain intensity, as well as DASH variable, descriptive statistics (mean, standard deviation, maximum, minimum, as well as range) were calculated. MANOVA was used to analyze all outcomes and show differences between and within groups of DASH and pain level

3.Results:

3.1. Demographic and sports training as well as clinical data:

Normality assumption testing and homogeneity of variance checks were the first steps in the data screening process. Following removing outliers with box and whisker plots, we performed a normality testing of the data with the Shapiro-Wilk test, which showed that the data was normally distributed ($P>0.05$).

Analyses of the subjects` demographic data in the present study show good homogeneity of the study population in age (22.9±3.69) with BMI of 24.1±1.7 also injury time values (2.77±0.698), as well training (years, hours, and dry land (7.02±1.8, 7.3±1.62 and 4.4±0.96), respectively. Moreover, no statistical substantial difference was found using Levene's test for assessing homogeneity of variance ($P>0.05$). (0.436 age; 0.741 injury time and training years, hours and dry land were 0.885, 0.756, and 0.058).

Due to the normally distributed nature of the data, the researcher was able to employ both parametric and nonparametric tests with these results. No significant differences were reported between the study and control groups in almost demographic, sport, as well clinical data. Unless there were significant differences concerning the dominant limb for each group ($P= 0.000$).

The mean values of BMI were 23.89±2 and 24.31±1.36kg/m2 for groups A and B, respectively. As well, the mean values of injury time were 2.8±0.696 and 2.75±0.72 for groups A and B, respectively, ($P<0.05$), but no differences ($P>0.05$) in gender, age, training …etc., among groups A and B (**Table 1**).

DASH parameter:

i. Within group comparison/ Impact of time.

A significant improvement of DASH values post-treatment in both groups in comparison with pre-values (P equals 0.000*), with a percentage were 73.92% for the study group versus 73.72% for the control one.

ii. Between groups` comparison/ Impact of treatment.

No substantial differences between the pre-treatment DASH values of the study vs. the control group (P equals 0.256). Comparison between the study and control groups of DASH values post-treatment reported significant improvement differences (P equals 0.000) in favor of the study group, **table (2).**

Table (1): Comparison of mean values of demographic, sport, and clinical data for groups

Items	Study Group Mean± SD or %	Control Group Mean± SD or %		Sig.
Age (years)	23.05 ±3.97	22.75 ±3.37	.798	NS
Gender	M/13 F/7 Sig. 180	M/14 F/6	Sig. :.074	NS
BMI	23.89 ±2	24.31 ±1.36	.437	NS
Train Ys	6.85 ±1.9	7.2 ±1.82	.556	NS
Train Hr.	7.5 ±1.64	7.1 ±1.62	.442	NS
Compete	C/13 N/7 Sig.180	C/14 N/6	Sig. .074	NS
Dry Train	4.55 ±1.1	4.25 ±0.79	.327	NS
Dominant	R/19 L/1 Sig. : .000	R/18 L/2	Sig. .000	S*
Injury Time	2.8 ±0.696	2.75 ±0.72	.824	NS
Distance	L/9 S/11 Sig. .655	L/8 S/12	.371	NS
Stroke Type	b/6 D/3 B/7 F/4 Sig.:.572	b/6 D/2 B/7 F/5	Sig. .432	NS
Diagnosis	R/15 L/5 Sig. .025	R/14 L/4	Sig. 0.074	NS

SD: Stander deviation S*: Significant %: Cumulative percentage R: right L: left C: club N: national M: male F: female b: breast D: dolphin B: back F: freestyle Ys: years Hr: hours BMI: body mass index L: limb

Visual Analogue scale scores parameter

i. Within group comparison/ Impact of time.

A significant improvement in VAS values post-treatment in both groups in comparison with pre-values (P equals 0.000*), with the mean value and percentage being 6.5; 74.29% for the study group versus 5.5; 65.09% for control one.

i. Between groups` comparison/ Impact of treatment.

No substantial differences among the pre-treatment VAS values of the study vs. the control group (P equals 0.365). Comparison between study and control groups of VAS values post-treatment reported significant improvement (P equals 0.003) in favor of the study group, **table (3).**

Table (2): Clinical DASH parameter statistical analysis across the study both groups.

Item	Study Group	Control Group	MD	P value	Significance	
Pre DASH	50.03±6.91	52.43±6.23	-2.4	-1.154	0.256	NS
Post DASH	13.05±2.21	13.78±1.67	-.72	-1.169	0.000	S*
Change	DE-73.92%	DE-73.72%				
MD	-36.98	-38.65				
Significance	0.000*	0.000*			0.000*	S*

***: high significant, P: probability, MD: mean differences, SE: standard error.**

Table (3): Visual analogue scale statistical analysis across the study both groups

Item	Study Group	Control Group	MD	F value	Sig.	
Pre VAS	8.75±1.07	8.45±0.99	.03	.917	.365	NS
Post VAS	2.25±0.55	2.95±0.83	0.7	3.16	.003	**S***
Total Change	DE-74.29%	DE-65.09%				
MD	-6.5	-5.5				
Significance	0.000*	0.000*			0.000*	**S***

***: high significant, P: probability, MD: mean differences, SE: standard error.**

4. Discussion:

About 38 to 75 % of 1262 swimmers surveyed by **Littlewood et al.** experienced previous shoulder pain severe enough to prevent them from training effectively, and Supraspinatus tendinopathy is the major cause of shoulder pain in elite swimmers. A range of interventions, both conservative and surgical, are currently used to treat this condition. Although the mechanism of action is poorly understood (19).

The current study's aim was to investigate the impact of the Graston technique on functional abilities as well as pain intensity in competitive swimmers with chronic supraspinatus tendinopathy .

Our results showed a significant improvement of DASH values post-treatment in both groups in comparison with pre-values (P equals 0.000*), with a percentage were 73.92% for the study group versus 73.72% for control one, also a significant improvement in VAS values post-treatment in both groups in comparison with pre-values (P equals 0.000*), with the mean value and percentage being 6.5; 74.29% for the study group versus 5.5; 65.09% for control one. Thus, the current study has revealed that the Graston technique with exercise has a significant superiority to decreased pain and improved function ability of DASH values post-treatment than exercise alone in swimmers with chronic supraspinatus tendinopathy .

According to the available research, IASTM is a novel approach that helps therapists detect as well as also treat soft-tissue injuries and musculofascial involvements. Combining this approach with appropriate exercises can lead to pain-free restoration of muscular range of motion and function. Clinical data supports the hypothesis that IASTM improves musculoskeletal flexibility by improving blood flow to the arteries and decreasing the consequences of local ischemia. Tools for soft tissue mobilization have been shown to improve treatment quality and effectiveness by reducing therapist hand pain as well as fatigue (20).

Instrument-assisted soft tissue mobilization, as hypothesized by recent clinical experiments, causes localized micro-trauma to the soft tissue, leading to microvascular and capillary bleeding, which in turn reinitiates the inflammatory process and activates the body's healing and reparative systems (20,21).

This inflammatory response initiates the healing process once again by increasing the circulation of blood, nutrients, as well as fibroblasts to the injured area, which in turn promotes the synthesis, deposition, as well as maturation of collagen (20). Several recent case studies and also outcome studies have shown that IASTM is beneficial for patients with both recent and long-standing injuries (21).

A number of recent case studies plus outcome studies have shown that IASTM is beneficial for patients with both acute as well as chronic injuries. A collegiate volleyball player, aged (21), was treated for costochondritis by **Aspegren et al.** using IASTM. After receiving treatment, both pain and function were discovered to have improved for these clinicians when playing volleyball (22).

There was another study that documented 3 case studies employing this method, all of which indicated reduced pain and improved function between patients with varying conditions (supraspinatus tendinosis, Achilles tendinosis, plantar fasciitis) (23).

Both active and passive lumbar range of motion (ROM) were both increased when IASTM was applied to a patient who had been diagnosed with low back pain and had been in a flexed position for too long (21). However, the current study is the first to demonstrate the benefit of using GT for improving function ability and pain in swimmers with chronic supraspinatus tendinitis after application of Grastone with exercise.

Concerning the short-term impacts of IASTM on pain-free ROM in a weightlifter having subacromial pain syndrome. Acutely, IASTM may improve the ability to flex the shoulder without experiencing pain. Incorporated into a treatment plan that also includes scapulothoracic mobilizations and stretches, IASTM has the potential to enhance patient satisfaction while also enhancing function and relieving pain. There is little evidence that this method improves the underlying patho-mechanics of SAPS; however, it may be useful in restoring ROM and decreasing pain so that the patient can experience the full advantages of a multimodal treatment plan (24).

The present study results were confirmed by **Cheatham and his colleagues** found that the Graston technique assists in short-term athletic performance improvement (20). Cheatham had explained the therapeutic mechanism of the Graston technique that is closely related to transverse friction massage through mechanoreceptors stimulating theorized to improve vibration sense by both clinician as well as patient, that enhance the clinician's capability to discover altered tissue properties whereas enhancing patient's awareness of changed sensations inside the treated tissues (25).

Karmail and his colleagues ensure that Graston technique is directly proportional to the applied pressure improving vascular reaction remodeling of the matrix of collagen (26).

In addition, the Graston technique is believed to offer a mechanical advantage for the clinician by allowing deeper penetration and also more localized treatment that reduces imposed stress (25). On their hands, plus the increasing perception of vibration of the therapist, which is thought to improve the ability to identify tissue adhesions (25).

For supraspinatus tendinitis with traumatic etiology, only graded exercises can effectively treat the condition (27).

The current body of evidence suggests that for those with rotator cuff tears, SIS, as well as rotator cuff tendinopathy, home exercises are just as helpful as supervised exercises in lowering shoulder pain as well as disability. This study's results of a reduction in shoulder pain and disability corroborate those of other studies (28).

The study by **Roy et al.** indicates that individuals with SIS can benefit from a 4-week program that consists of motor control plus strengthening exercises to decrease pain and increase function (29). As strength training directly affects the functional capacity of the dynamic stabilizers of the glenohumeral joint.

5.Conclusion:

Based on current clinical trial findings could ensure that adding the Graston technique to conventional therapy is an effective therapeutic modality to improve functional abilities, and pain intensity, mainly at the upper fibers of the trapezius in competitive swimmers with chronic supraspinatus tendinopathy. These findings indicate that the Graston technique could be recommended in dealing with patients with chronic supraspinatus tendinopathy.

Limitation of this study:

This study did not examine the long-term impacts of the utilized treatment beside this study was limited to male.

Recommendations:

More studies are required to demonstrate the long-term impact, more studies should include participants of varying ages and sex.

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Conflict of Interests:

The authors confirmed that this article's content has no conflict of interest.

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References:

1. Bak, K. (2010). The practical management of swimmer's painful shoulder: aetiology, diagnosis and treatment. Clinical Journal of Sport Medicine, 20(5), 386-390.
2. Vila Dieguez, O., & Barden, J. M. (2020). Body roll differences in freestyle swimming between swimmers with and without shoulder pain. Sports Biomechanics, 1-14.
3. Sein, M. L., Walton, J., Linklater, J., Appleyard, R., Kirkbride, B., Kuah, D., & Murrell, G. A. (2010). Shoulder pain in elite swimmers: primarily due to swim-volume-induced supraspinatus tendinopathy. British journal of sports medicine, 44(2), 105-113.
4. Matzkin, E., Suslavich, K., & Wes, D. (2016). Swimmer's shoulder: painful shoulder in the competitive swimmer. Journal of the American Academy of Orthopaedic Surgeons, 24(8), 527-536.
5. Bansal, K., & Padamkumar, S. (2011). A comparative study between the efficacy of therapeutic ultrasound and soft tissue massage (deep friction massage) in supraspinatus tendinitis. Indian Journal of Physiotherapy and Occupational Therapy, 5(2), 80-84.
6. MacDonald, N., Baker, R., & Cheatham, S. W. (2016). The effects of instrument assisted soft tissue mobilization on lower extremity muscle

performance: a randomized controlled trial. International journal of sports physical therapy, 11(7), 1040.
7. Silbaugh, K. (2013). Validity of instrument assisted soft tissue mobilization for detecting myofascial adhesions through secondary diagnostic ultrasound analysis (Doctoral dissertation, Indiana State University).
8. DeStefano, R., & Hooper, J. (2009). Muscle Medicine: The Revolutionary Approach to Maintaining, Strengthening, and Repairing Your Muscles and Joints. Simon and Schuster.
9. Roy, J. S., Macdermid, J. C., & Woodhouse, L. J. (2009). Measuring shoulder function: a systematic review of four questionnaires. Arthritis Care & Research: Official Journal of the American College of Rheumatology, 61(5), 623-632.
10. Jiang, R., Zhang, L., & Yu, H. (2022). Development and validity of deep learning system to evaluating endoscopic severity scale of ulcerative colitis based on visual analogue scale. Gastrointestinal Endoscopy, 95(6), AB213.
11. Biskovich, K. (2013). Physical therapy corner: the graston® technique and treatment of soft tissue dysfunction. JBJS Journal of Orthopaedics for Physician Assistants, 1(1), 40.
12. Reethu, G. R., Jhalegar, M. J., Jagadeesh, S. L., Bhuvaneshwari, G., Babu, A. G., & Pavankumar, P. (2022). Effect of pre-cooling methods on shelf life of cold stored tuberose florets. Journal of Pharmacognosy and Phytochemistry, 11(5), 181-185.
13. Kazemipour, N., Faramarzi, M., & Banitalebi, E. (2022). The Effect of 12 Weeks of Theraband Resistance Training on IGF-1 and FGF-2 Levels and Their Relationships with Myokines on Bone Mineral Density of Osteosarcopenic Obese Women. Jentashapir Journal of Cellular and Molecular Biology, 13(3).
14. Wilk, K. E., Macrina, L. C., Fleisig, G. S., Porterfield, R., Simpson, C. D., Harker, P., & Andrews, J. R. (2011). Correlation of glenohumeral internal rotation deficit and total rotational motion to shoulder injuries in professional baseball pitchers. The American journal of sports medicine, 39(2), 329-335.
15. Laudner, K., Compton, B. D., McLoda, T. A., & Walters, C. M. (2014). Acute effects of instrument assisted soft tissue mobilization for improving posterior shoulder range of motion in collegiate baseball players. International journal of sports physical therapy, 9(1), 1.
16. Paula, R. C., Francisco, A., Mariana A.A., Melina, N. H., Amilton, V.& Tania F.S. (2015). Effects of Stretching and Strengthening Exercises, With and Without Manual Therapy, on Scapular Kinematics, Function, and Pain in Individuals with Shoulder Impingement: A Randomized Controlled Trial.journal of orthopedic& sports physical therapy. 45, 12.
17. Miners, A.L.& Bougie, T.L., (2011). Chronic Achilles tendinopathy: a case study of treatment incorporating active and passive tissue warm-up, Graston Technique, ART, eccentric exercise, and cryotherapy. J Can Chiropr Assoc.55:269–279.
18. Jain, N. B., Wilcox, R.B., Katz, J.N. & Higgins, L.D., (2013): Clinical Examination of the Rotator Cuff.PM-R; 5(1): 45_56.
19. Littlewood, C., Malliaras, P., Mawson, S., May, S., & Walters, S. J. (2014). Self-managed loaded exercise versus usual physiotherapy treatment for rotator cuff tendinopathy: a pilot randomised controlled trial. Physiotherapy, 100(1), 54-60.
20. Emshi, Z. A., Okhovatian, F., Kojidi, M. M., Baghban, A. A., & Azimi, H. (2021). Comparison of the effects of instrument assisted soft tissue mobilization and dry needling on active myofascial trigger points of upper trapezius muscle. Medical Journal of the Islamic Republic of Iran, 35, 59.
21. Laudner, K., Compton, B. D., McLoda, T. A., & Walters, C. M. (2014). Acute effects of instrument assisted soft tissue mobilization for improving posterior shoulder range of motion in collegiate baseball players. International journal of sports physical therapy, 9(1), 1.
22. Aspegren, D., Hyde, T., & Miller, M. (2007). Conservative treatment of a female collegiate volleyball player with costochondritis. Journal of manipulative and physiological therapeutics, 30(4), 321-325.
23. Hammer WI. The effect of mechanical load on degenerated soft tissue. J Bodywork Movement Ther. 2008; 12: 246–256.
24. Coviello, J. P., Kakar, R. S., & Reynolds, T. J. (2017). Short-term effects of instrument-assisted soft tissue mobilization on pain free range of motion in a weightlifter with subacromial pain syndrome. International Journal of Sports Physical Therapy, 12(1), 144.
25. Cheatham, S. W., Lee, M., Cain, M., & Baker, R. (2016). The efficacy of instrument assisted soft tissue mobilization: a systematic review. The Journal of the Canadian Chiropractic Association, 60(3), 200.

26. Karmali, A., Walizada, A., & Stuber, K. (2019). The efficacy of instrument-assisted soft tissue mobilization for musculoskeletal pain: A systematic review. Journal of Contemporary Chiropractic, 2, 25-33.
27. Yadav, M., Thombare, N., Naqvi, W. M., & Bele, A. W. (2020). Impact of Physiotherapy Rehabilitation Program on Post-Operative Stiffness of Supraspinatus Tendinitis. Journal of Evolution of Medical and Dental Sciences, 9(33), 2403-6.
28. Santello, G., Rossi, D. M., Martins, J., Libardoni, T. D. C., & de Oliveira, A. S. (2020). Effects on shoulder pain and disability of teaching patients with shoulder pain a home-based exercise program: a randomized controlled trial. Clinical Rehabilitation, 34(10), 1245-1255
29. Roy, J. S., Moffet, H., Hébert, L. J., & Lirette, R. (2009). Effect of motor control and strengthening exercises on shoulder function in persons with impingement syndrome: a single-subject study design. Manual therapy, 14(2), 180-188.