

Effect of 4 week on two passive stretch maneuvers on pectoralis minor length and scapular kinematics among collegiate swimmer

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Background & objective: Swimming is a sport enjoyed by all ages. Approximately 100 million Americans consider themselves swimmer, making swimming the most popular sport in the united states. Some of these people swim competitively, other swim for fitness, and other for reaction. Swimming can be done safely by people with musculoskeletal systems that cannot withstand the impact forces found in running, jogging or jumping. Swimming is also highly regarded as an aerobic activity. Competitive swimmers may cover 10,000 to 14,000 meters a day 6 to 7 days a week. Some distance swimmers may swim up to 24,000 meters a day. This equates to 16,000 shoulder revolutions per week.

Swimming is an unusual sport in that the shoulders and upper extremities are used for locomotion, while at the same time requiring above average shoulder flexibility and range of motion (ROM) for maximal efficiency.

This is often associated with an undesirable increase in joint laxity. Furthermore, it is performed in a fluid medium, which offers more resistance to movement than air.

This combination of unnatural demands can lead to a spectrum of overuse injuries seen in the swimmer's shoulder, the most common of which is rotator cuff tendinitis and pectoralis minor tightness. Observation of the scapular posture is one of the most important component of the physical examination in overhead athletes.

Design of study: Experimental study.

Methods: A convenience sample of 30 swimmers subject divided into two group, Group A and Group B who fulfilled the inclusion criteria were included in the study. After the collection of demographic data, a detailed tightness of pectoralis minor was measured by inch tape method. The measurement were taken by standing the participant erect with resting his arm at their side. The distance was taken between origin and insertion of the muscle. The scapular protraction was measured in three position of the shoulder joint i.e 0⁰, 45⁰, and 90⁰. The lateral part of caliper was placed on top of inferior angle and medial part of scapula was placed on

corresponding spinous process. The scapular measurement for maximum abduction was measured with gravity inclinometer, the device was placed in the root of spine of scapula. This position was established so that when subjects elevate his arm, their arm were raised in the scapular plane (40° anterior to the frontal plane) while maintaining the contact with the guide pole. The measurement is taken in the maximum elevation of the arm.

RESULT: After measurement of the pectoralis minor length the mean in 0 week for Group A($X=7.56$), Group B ($X=8.8$), and in 4th week for Group A($X=7.66$), Group B ($X=9.65$) The mean of **ROTATION 90 UPWARDS** 0 week for Group A($X=15$), Group B

($X=11.9$) mean of **ROTATION 90 UPWARDS** 4th week for Group A($X=16.33$), Group B($X=15.46$) mean of **SCAPULAR PRET** 0 week for Group A($X=8.38$), Group B($X=8.162$) mean of **SCAPULAR PRET** 4th week for Group A($X=8.48$), Group B($X=8.54$) With t-value and p-value of **pect minor length cm** on pre(0 week) is $t=0.02476$ and ($p>0.05$) t-value and p-value after 4th week is $t=3.275$ and ($p<0.05$) With t-value and p-value of

ROTATION 90 UPWARDS on pre(0 week) is $t=0.04057$ and ($p>0.05$) t-value and p-value after 4th week is $t=1.3096$ and ($p<0.05$) With t-value and p-value of **SCAPULAR PRET** on pre(1st week) is $t=0.00276$ and ($p>0.05$) t-value and p-value after 4th week is $t=0.0034$ and ($p<0.05$) Also the graphical representation of data clearly shows that as compared to group A Group B has significant difference in (pre-post session) in all three variable This shows that Group B has shown significant improvement than that of Group A.

Interpretation & conclusion: On comparison of group A and group B it was seen that there was no statistically significant difference between the pre intervention scores of Group A and Group B in the study of total 30 patients On comparison of Group A and Group B it was seen that there was a statistically significant difference in post intervention score between Group A and Group B

Key words: pectoralis minor tightness, scapular upward rotation and protraction.

Introduction

Competitive swimmers routinely swim six to seven days per week during the competitive season, reaching distances of six to eight miles per practice, which equates to approximately 2500 sequential shoulder revolutions per day.¹ As such, the scapular orientations and kinematics during humeral elevation tasks of swimmers can be altered due to changes of surrounding musculature including weakness, fatigue, and inflexibility.² Optimal shoulder function is closely associated with proper scapular orientation and motion.²⁻⁵ Therefore, it is vital that

any alterations to the periscapular musculature are addressed through preventative and rehabilitative interventions among such athletes.

Scapular dyskinesis has been associated with several shoulder pathologies, such as subacromial impingement syndrome,^{6,9} rotator cuff pathology,^{10,12} internal impingement,¹³ glenohumeral instability,^{14,15} and adhesive capsulitis.^{16,18} One specific cause of scapular dyskinesis may be an abnormally shortened pectoralis minor muscle.^{8,19} Diminished pectoralis minor flexibility prohibits optimal scapular kinematics, specifically in upward rotation, external rotation, and posterior tilting.^{20,21} Therefore, tightness of the pectoralis minor may be a contributing factor to various shoulder injuries, most frequently, subacromial impingement syndrome.^{6,8,22} Furthermore, tightness of the pectoralis minor may be more prevalent among swimmers due to the repetitive overhead nature of their sport.²³

Due to the potential for development of scapular dyskinesia and upper extremity injury when pectoralis minor tightness is present, stretching of the pectoralis minor muscle is

believed to be critical in the prevention and treatment of shoulder dysfunction. Various stretching techniques to lengthen the pectoralis minor are currently used in clinical practice.^{19,21} However, results of studies that have investigated optimal stretching techniques for the pectoralis minor are conflicting, which has caused increased confusion among researchers and clinicians.^{20,21,24,26}

Further investigations are necessary to determine how stretching exercises alone might acutely affect the length of the pectoralis minor, as well as the dynamic orientation of the scapula. Therefore, the purpose of this study is to compare the acute effects of two passive stretch maneuvers aimed at lengthening the pectoralis minor and the subsequent effects on scapular kinematics among a group of collegiate swimmers. The authors hypothesized that the passive stretching maneuvers utilized in this study would acutely change the length of the pectoralis minor muscle and affect scapular kinematics among a sample of collegiate swimmers to provide optimal congruence between the glenoid and the humeral head. The shoulder joint enjoys mobility at the cost of stability with respect to bony articulation. The shoulder complex is highly dependent upon soft tissue relationships to maintain joint congruency.

The interaction of these muscular ligaments and capsular structure leads to coordinated movements between the glenohumeral and scapulothoracic rhythm. During dynamic arm movement the scapula must move synchronously with the humerus. Contribution from the scapula has long been considered essential for normal shoulder function.

Concomitant changes including increased protraction or decreased upward rotations have been identified in the scapular motion of athletes.

The scapula has long been considered essential for normal shoulder function. Concomitant changes including increased protraction or decreased upward rotations have been identified in the scapular motion of athletes. A typical dysfunction pattern is when the scapula adopts a protracted and downwardly rotated position. This may increase tension and irritation on the upper limb neural system. It is also associated with an increased risk of impingement and increase laxity of the anterior glenohumeral structures. Awareness of and clinical test for the position and motion of scapula should be incorporated into the routine examination of the painful shoulder. Observation of the scapula posture is one of the most important components of the physical examinations in overhead athletes.

The knowledge of scapula kinematic function and evaluation is growing and understanding the role of scapula in shoulder function and dysfunction is evolving. Movement at the glenohumeral joint can take place in all directions: flexion and extension; abduction and adduction; internal and external rotation; and circumduction.

Each movement is brought about by different groups of muscles. Rotation of the humerus is accomplished by a group of four muscles, subscapularis, supraspinatus, infraspinatus and teres minor collectively called rotator cuff. These muscles originate on different parts of scapula, insert like a cuff around the perimeter of the humeral head, where the tendons blend with the joint capsule. In addition to externally and internally rotating the humerus, the rotator cuff helps stabilize the joint during abduction by pulling the humeral head into the glenoid fossa.

Scapular rotation is accomplished by the trapezius and serratus anterior muscles. Trapezius originates on the clavicle and the thoracic spine and inserts on the scapula. Scapular muscles for swimmers are the middle and lower serratus anterior muscles produce scapular upward rotations, posterior tilting and external rotation. Upper trapezius assists in medial stabilization and prevention of excess superior translation of the humeral head, as well as production of glenohumeral external rotation during arm elevation. It is important to assess the difference in static scapular position among swimmers to better understand the exact biomechanical changes in sports like swimming.

METHODOLOGY

Thirty healthy swimming athletes (age = 22.13 ± 2.16 years, height = $171.6 \text{ cm} \pm 6.38 \text{ cm}$, weight = $65.13 \pm 6.56 \text{ kg}$) participated in the study. All participants were in season at the time of data collection. Both left and right

shoulders of each subject were used for data collection. Shoulders of swimmers that had a recent history (past 2 months) of upper extremity injury or any history of upper extremity surgery were excluded from the study. Of the 30 subjects, 8 shoulders were excluded from analysis due to previous injury leaving 50 shoulders for final data analysis; control shoulders (n=15), focused stretch shoulders (n=15), gross stretch shoulders .

Instrumentation

A standard tape measure was used to measure pectoralis minor length. A gravity inclinometer was used to measure scapular kinematics, Scapular protraction was measured by vernier caliper.

Procedure:-

Testing occurred during a single session at the participating team's swimming facilities or within a -biomechanics using a pre-test post-test design. Each shoulder was randomly assigned as either focused stretch shoulder, gross stretch shoulder, or control shoulder. All subjects read and signed an informed consent form approved by the institutional review board prior to participation. The study was conducted in accordance with the Helsinki declaration. Scapular kinematic data for the experimental shoulders (focused stretch, gross stretch) were measured immediately before and after an application of one of the two passive stretch treatments. Control shoulders received initial scapular kinematic measurements and post-intervention measurements after an approximate 1.5 minute rest period without receiving any form of treatment. This rest period was approximately the same amount of time necessary to apply the assigned stretch to the experimental shoulders.

Pectoralis Minor Length Measurement

To measure the length of the pectoralis minor participants were standing erect with their test arm resting at their side. A tape measure was used to measure the linear distance between the origin and insertion of the muscle. The primary investigator of the study performed all measurements. The origin was defined as the inferior aspect of the 4th rib, which was one finger width lateral to the sternum, just lateral to the sternocostal junction.

The insertion was defined as the medial-inferior aspect of the coracoid process. This method of measuring pectoralis minor length has previously been proven to be valid

- intraclass correlation coefficients between 0.82 to 0.87 when compared with measurements made using an electromagnetic tracking system.²⁷

Scapular Kinematic Measurement

The measurement is to be conducted in swimmers static scapular position. After a verbal description of the measurement procedure, the method is to be demonstrated to the subject. The measurement protocol utilized in this study for scapular upward rotation describe by Johnson. et al¹³. To measure the scapular upward rotation the root of the scapular spine will be identified and marked in rest. The left edge of the gravity inclinometer will be placed on this mark, and another mark will be placed where the right edge of the inclinometer rest on the scapula.

These mark ensure that the gravity inclinometer rested on the same location on the scapula in repeated measures. Then the glenohumeral joint is elevated, a vertical guided pole will be secure to the plinth, the standing position of the subjects will be standardized by lines marked on the floor. The position will be established so that when subjects elevates his arm, their arm would raise in the scapular plane (40° anterior to the frontal plane) while maintaining the contact with the guide pole. The measurement/reading is taken in the maximum elevation of the arm.

Scapular protraction measurement

Scapular protraction measurement will be taken with the participant standing with normal relaxed posture the measurement will be performed at three positions (0° , 45° , 90°) hands on hips and 90° of glenohumeral abduction with maximum internal rotation.

First the inferior angle of scapula will be palpated and lateral arm of the caliper will be placed at the top of the inferior angle. The medial arm of the caliper will be positioned at the corresponding spinous process, and the measurement will be recorded. This will be repeated three times and the measurement will be use

Pectoralis Minor Stretches

It is accepted that a passive stretch duration of 15 to 30 seconds and a frequency of 2 to 4 repetitions is appropriate for acutely improving flexibility.^{32,33} Thus, the focused and gross passive stretching interventions in this study were performed for two sequential repetitions, holding the stretches for 30 seconds, with a 30 second break between each stretch. The primary investigator applied all stretches at the end range of motion.

For the focused stretch shoulders, the authors placed each subject in a supine position with the test arm at their side while the primary investigator palpated medially into the proximal axilla, followed by proceeding superiorly towards the coracoid process. This maneuver allowed the investigator's fingers to be fixed posterior to the proximal end of the pectoralis minor muscle.

The investigator then applied pressure in the anterior direction, similar to attempting to lift the muscle, thereby applying tensile force directly to the pectoralis minor. The opposite hand of the investigator was used to stabilize the scapula and humeral head ([Figure 1](#)).

For the gross-stretch, subjects were positioned in the supine position with the test arm abducted and externally rotated to 90° and the elbow flexed to 90°. The investigator stabilized each subject's body by placing a hand on the contralateral coracoid. The investigator then passively, horizontally abducted the subject's shoulder.

Statistical Analyses

A Paired T test with repeated measures on time was utilized for comparison. Time (pre-, post-test) and shoulder assignment (control, focused stretch, gross stretch) were the independent variables. The dependent variables included a linear measurement of pectoralis minor length, as well as angular measurements of scapular upward/downward rotation, external/internal rotation, and anterior/posterior tilting. If a significant group-by-time interaction was found. Within-group effect size was calculated as (post-intervention mean – pre-intervention mean)/pre-intervention standard deviation. The effect size calculations provide an indication of clinical meaningfulness of changes among the dependent variables. Alpha level was set a priori at .05. All data were analyzed using SPSS software (Version 21.0, IBM Corp)

RESULT

Descriptive data for pre- and post-test pectoralis minor length and scapular kinematics of the two groups are summarized in [Tables 1-8](#). Pectoralis minor length showed a significant interaction effect ($p = .0028$). The effect size suggests that a small to moderate amount of the change in pectoralis minor length may be attributed to the treatment.

Table 1: Mean and SD OF pectoralis minor length for the Group A and Group B

Demographic data(pectoralis minor length cm)	GroupA	GroupB
	Mean	sd
AT 0 WEEK	7.56	0.59
AT 4TH WEEK	7.66	0.58
Demographic data(SCAPULAR UPWARDS ROTATION)	GroupA	GroupB
	Mean	sd
AT 0 WEEK	15	6.26
AT 4TH WEEK	16.33	5.97

Table 2: Mean and SD of scapular upwards rotation for the Group A and Group B

Table 3: Mean and SD of scapula protraction for the Group A and Group B

Demographic data(SCAPULAR PROTRACTION)	GroupA	GroupB
	mean	sd
AT 0 WEEK	8.38	5.51
AT 4TH WEEK	8.48	5.48
Variable- pct minor length cm	Group A	Group B
	T value	P value
PRE vs POST SESSION	0.02476	0.98

Table 4: comparison of mean value for pectoralis minor length between Group A and Group B

Variable- ROTATION 90 UPWARDS	Group A		Group B	
	T value	P value	T value	P value
PRE vs POST SESSION	0.04057	0.967	1.3096	0.200

Table 5: Comparison of mean value for scapula upwards rotation between Group A and Group B

Variable- SCAPULAR PROTRACTION	Group A		Group B	
	T value	P value	T value	P value
PRE vs POST SESSION	0.00276	0.997	0.0034	0.9973

Table 6: Comparison of mean value for scapula protraction between Group A and Group B

MEAN DIFF(pre-post)	GroupA		GroupB	
	Mean diff	sd	Mean diff	Sd
PECTORALIS MINOR LENGTH	0.093	0.143	0.853	0.366
SCAPULA UPWARDS ROTATION	1.333	2.288	3.3	2.234
SCAPULAR PROTRACTION	0.1	0.107	0.566	0.335

Table 7: Comparison of mean difference and SD between Group A and Group B

MEAN DIFF(pre-post)	Group A vs Group B	
	T value	P value
pcet minor length cm	1.212	0.235
ROTATION 90 UPWARDS	0.038	0.969
SCAPULAR PRET	0.0002	0.999

Table 8: comparison of mean difference between Group A and Group B

Comparison of mean value and standard deviation for age between Group A and Group B

Comparison of mean value and standard deviation for weight between Group A and Group B

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Comparison of mean value and standard deviation for height between Group A and Group B

Comparison of mean for pectoralis minor length between Group A and Group B

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Comparison of mean for upward rotation between Group A and Group B

Comparison of mean for scapular protraction between Group A and Group B

DISCUSSION

[Jeffrey G. Williams](#) et. al did the acute effect of two passive stretch maneuvers on pectoralis minor length and scapular kinematics among collegiate swimmer. They found that the gross stretch shoulders had a significant increase in pectoralis minor length compared to the control shoulders ($P=.007$). There were no other significant changes in length for either the focused stretch or control shoulders ($P>.07$). No statistically significant ($P>.08$) differences for all three scapular kinematic variables were found among any of the three groups ($P>.08$)

In our study effect of 4 week on two passive stretch maneuvers on pectoralis minor length and scapular kinematics among collegiate swimmer. The total participants were 30 (15 in Group A and 15 in Group B). The analysis of mean and standard Deviation(S.D) of age for Group A($X=23.4,SD=1.63$), Group B ($X=24.86,SD=2.416$). The analysis of mean and standard Deviation(S.D) of wt for Group A($X=68.6,SD=7.05$), Group B ($X=68.33,SD=4.639$). The analysis of mean and standard Deviation(S.D) of ht for Group A($X=161.66,SD=5.58$), Group B ($X=174.86,SD=5.566$) The analysis of mean and standard Deviation(S.D) of **PECTORALIS MINOR LENGTH cm** IN 0 week for Group A($X=7.56,SD=0.59$), Group B ($X=8.8,SD=1.146$) The analysis of mean and standard Deviation(S.D) of **PECTORALIS MINOR LENGTH cm** in 4th week for Group A ($X=7.66,SD=0.58$), Group B ($X=9.65,SD=0.97$) The analysis of mean and standard Deviation(S.D) of **ROTATION 90 UPWARDS** 0 week for Group A ($X=15,SD=6.26$), Group B($X=11.9,SD=5.312$) The analysis of mean and standard Deviation(S.D) of **ROTATION 90 UPWARDS** 4th week for Group A ($X=16.33,SD=5.97$), Group B ($X=15.46,SD=4.824$)

The analysis of mean and standard Deviation(S.D) of **SCAPULAR PROTRACTION** 0 week for Group A($X=8.38,SD=5.51$), Group B ($X=8.162,SD=0.67$) The analysis of mean and standard Deviation(S.D) of **SCAPULAR PROTRACTION** 4th week for Group A($X=8.48,SD=5.48$), Group B ($X=8.54,SD=0.66$) With t-value and p-value of **pectoralis minor length cm** on pre(0 week) is $t=0.02476$ and ($p>0.05$) t-value and p-value after 4th week is $t=3.275$ and ($p<0.05$) With t-value and p-value of **ROTATION 90 UPWARDS** on pre (0 week) is $t=0.04057$ and ($p>0.05$) t-value and p-value after 4th week is $t=1.3096$ and ($p<0.05$) With t-value and p-value of

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Also the graphical representation of data clearly shows that as compared to group A Group B has significant difference in(pre-post session)in all three variable. This shows that Group B has shown significant improvement than that of Group A.

Borstad and Ludewiget al. Compared three pectoralis minor stretches. Although, all three stretches were reported to increase the length of the pectoralis minor during the stretch period, the “unilateral self-stretch” was found to create the most tissue lengthening. This stretch was performed in a standing position with the target shoulder abducted to 90° and the elbow flexed to 90°. With the hand's volar surface of the target arm placed against a vertical door frame or other flat rigid structure the subject then rotated their trunk away from the target shoulder.

The gross stretch performed in our investigation was similar to Borstad and Ludwig's²⁴ self-stretch as both stretching maneuvers place the humerus in an abducted and externally rotated position while stretching the shoulder further into horizontal abduction and sequentially retracting the scapula. Similar to Borstad and Ludwig's findings, the gross stretch procedure in the current study showed an increase in the length of the pectoralis minor compared to control shoulders. This shoulder position is in accordance with other investigators who suggest that applying a stretch to the pectoralis minor would require movement of the muscle's insertion in a posterior direction in conjunction with scapular retraction that is performed at or above 30° of flexion or elevation in the scapular plane (scaption), thereby lengthening the muscle. The authors specifically chose to perform the gross stretch with the subjects lying supine as it allowed the investigator to better control the amount of overpressure applied during the stretches. Subjects performing the stretch independently in a standing position may demonstrate varying amounts of applied overpressure to the shoulder during the stretch.

Wang et.al. provided subjects with a home exercise program that incorporated gross strengthening of the shoulder complex as well as a stretching procedure for the pectoralis minor over a six week period. A corner stretching exercise, similar to the gross stretch used in the current research, was performed with the subjects' hands above his or her head on adjoining corner walls. The subjects leaned into the wall in order to feel an anterior chest and shoulder stretch and hold for duration of ten seconds and ten repetitions. The researchers'

results revealed significantly less scapular upward rotation and greater internal rotation and inferior translation of the scapula at a horizontal arm position following the exercise program. However, McClure et al³⁸ prescribed a six-week home exercise program to subjects diagnosed with subacromial impingement syndrome using a similar selfstretch and reported no significant kinematic changes.

CONCLUSION

In our study, result reveals that the subject in experimental group B shows significant change in all three variable with p value<0.05

Group A also showed minor change in all three variable of total participant 30

On comparison of group A and group B it was seen that there was no statistically significant difference between the pre intervention scores of Group A and Group B in the study of total 30 patients

On comparison of Group A and Group B it was seen that there was a statistically significant difference in post intervention score between Group A and Group B

LIMITATION

Hand function is as important as shoulder function in swimmer but hand function is not assessed in this study.

Neck extensor is also in a constant isometric contraction along with protectors of shoulder. The study would be more significant if we would have considered neck movement along with shoulder movement.

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