Exercises Tailored to Meet the Needs of Submarine Pitchers

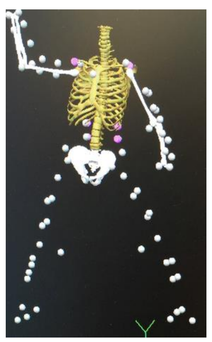
Kurtis Mullaney, SPT; Michael Klein, SPT; Shawn D. Felton, EdD, ATC, LAT; Kelley Henderson, M.Ed., ATC, LAT
College Health Professions and Social Work, Department of Rehabilitation Sciences

ABSTRACT

Background: In order to remain healthy while performing at a high level, athletes must exercise in a manner that is functional and translatable to the movement being produced during sport. In order to accomplish this, exercises are often modified to meet the specific demands of different sporting activities (Truedson, Sexton, and Pettitt 2012). **Purpose**: Although many studies have been performed on several aspects of baseball pitching, few studies have focused on the submarine pitcher. This pilot study investigated the difference in the activation patterns of select muscles for subjects conducting two exercises: the cable retraction with external rotation exercise and the modified version that has been tailored to the submarine pitcher. The following research was performed to advance the literature devoted to the specific needs of submarine pitchers, and to raise awareness on the lack of literature devoted to this style of throwing. **Subjects**: 16 healthy males ages 18-35 with previous high school, college, and/or professional baseball experience participated in this study. **Methods**: Each subject was observed performing five repetitions of the two exercises, while motion and muscle firing patterns of the posterior deltoid, the infraspinatus, the middle trapezius, and the lower trapezius were captured using the Qualisys Motion Capture System in conjunction with the Noraxon SEMG system. **Results**: No significant differences were found between the two exercises in terms of muscle activation patterns of the four muscles being studied. A positive correlation was found between the muscle activation patterns of the two exercises, indicating that both exercises may accomplish the same goal when it comes to strengthening the four targeted muscles.

OBJECTIVE

An article written by Truedson, Sexton, and Pettitt (2012) proposed that exercises should be tailored to meet the sport specific needs of submarine pitchers. To the knowledge of the researchers, this is the only published article that discusses this topic. It described two exercises commonly used for strengthening and rehabilitation: the kneeling deceleration exercise and the cable retraction with external rotation (ER) exercise. It explained how these exercises should be modified to meet the needs of the submarine pitcher. This raises the question of whether or not these modifications are successful at altering muscle recruitment patterns to make these exercises more beneficial to this population of pitchers. The purpose of this study was to determine if muscle recruitment patterns differ during the modified cable retraction with ER exercise compared to when the exercise is conducted in the traditional manner. The researchers hypothesized there would be a difference in muscle recruitment patterns when comparing the two methods of the exercise. The null hypothesis was that there would be no significant difference in muscle recruitment patterns when comparing the modified form of the exercise to the traditional form of the exercise.



METHODS/PROCEDURE

- ❑ A pilot study using a convenience sampling method to recruit healthy male participants from the student body of a local university and from local minor league baseball teams was conducted. Data from twelve participants were analyzed. The inclusion criteria consisted of males ages 18-35 with a history of participation in the sport of baseball at least at the high school level.
- ❑ Joint kinematics of the upper extremities and neuromuscular activation of four muscles were assessed using a motion capture and electromyography system. The four muscles of interest included: Posterior Deltoid, Infraspinatus, Middle Trapezius, and Lower Trapezius due to the high activity levels of these muscles during the deceleration phase of throwing, and because the exercise that was performed is aimed at targeting these muscles (DiGiovine, Jobe, Pink, & Perry 1992; Paine, & Voight 2013).
- ❑ The Procedure is outlined below:
- Upon arriving to the study, each participant provided written informed consent.
- The skin was prepared for electrode placement, and electrodes were placed over the muscle bellies of the posterior deltoid, infraspinatus, middle trapezius, and lower trapezius muscles.
- Once a short warm-up was completed, the maximum voluntary isometric contractions (MVICs) of the infraspinatus, lower, and middle trapezius, and posterior deltoid muscles of each subject were collected utilizing standard manual muscle testing (MMT) techniques described by Kendall, McCreary, Provance, Rodgers, and Romani (2005).
- MVIC capture was performed by two researchers; one researcher performed the muscle testing procedure while the the second researcher simultaneously captured the MVIC data via the Noraxon surface EMG system.
- Qualisys motion analysis markers were placed over each participant on appropriate anatomical landmarks to track joint movement in real time as each participant performed the exercises.
- Once the instruments were appropriately prepared and calibrated each subject completed one set of five repetitions of the traditional exercise and one set of five repetitions of the modified version.
- The second through forth repetitions gathered for each exercise were used for data analysis.

RESULTS

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	M Posterior Deltoid MAX	1.05593942	12	1.024477276	.295741116
	T Posterior Deltoid MAX	1.13088842	12	1.297209690	.374472182
Pair 2	M Infraspinatus_MAX	1.20247367	12	1.449352933	.418392153
	T Infraspinatus_MAX	.76956275	12	.409651716	.118313999
Pair 3	M Mid Trap_MAX	1.50935683	12	1.197137373	.345583792
	T Mid Trap_MAX	1.48021142	12	.881891413	.254580122
Pair 4	M Low Trap_MAX	.82167742	12	.526592278	.152014097
	T Low Trap_MAX	.90977975	12	.567675618	.163873836

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	M Posterior Deltoid MAX & T Posterior Deltoid MAX	12	.913	.000
Pair 2	M Infraspinatus_MAX & T Infraspinatus_MAX	12	.749	.005
Pair 3	M Mid Trap_MAX & T Mid Trap_MAX	12	.765	.004
Pair 4	M Low Trap_MAX & T Low Trap_MAX	12	.850	.000

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	M Posterior Deltoid MAX - T Posterior Deltoid MAX	-.074949000	.552719184	.159556285	-.426130015	.276232015	-.470	11	.648
Pair 2	M Infraspinatus_MAX - T Infraspinatus_MAX	.432910917	1.174169455	.338953526	-.313120763	1.178942596	1.277	11	.228
Pair 3	M Mid Trap_MAX - T Mid Trap_MAX	.029145417	.771127754	.222605408	-.460805784	.519096617	.131	11	.898
Pair 4	M Low Trap_MAX - T Low Trap_MAX	-.088102333	.302059226	.087196988	-.280021609	.103816943	-1.010	11	.334

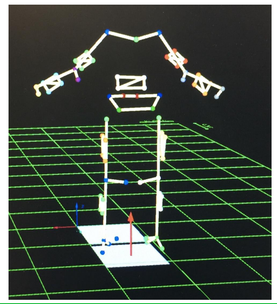
CORRELATIONS – ANGLE OF THE GLENOHUMERAL JOINT DURING PEAK MUSCLE ACTIVITY

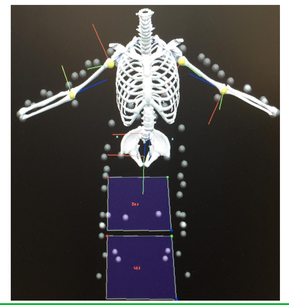
		T Posterior Deltoid Y	T Infraspinatus Y	T Mid Trap Y	T Low Trap y
M Posterior Deltoid Y	Pearson Correlation	-.259	.175	-.340	-.334
	Sig. (2-tailed)	.415	.587	.280	.289
	N	12	12	12	12
M Infraspinatus Y	Pearson Correlation	-.451	.206	.147	-.285
	Sig. (2-tailed)	.141	.521	.649	.370
	N	12	12	12	12
M Mid Trap Y	Pearson Correlation	-.152	-.062	.018	.060
	Sig. (2-tailed)	.636	.849	.956	.853
	N	12	12	12	12
M Low Trap y	Pearson Correlation	-.236	.229	-.218	-.217
	Sig. (2-tailed)	.461	.474	.496	.498
	N	12	12	12	12

**. Correlation is significant at the 0.01 level (2-tailed).

PAIRED SAMPLES TEST - ANGLE OF GLENOHUMERAL ABDUCTION DURING PEAK MUSCLE ACTIVITY

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	M Posterior Deltoid Y – T Posterior Deltoid Y	-13.173294833	13.663971208	3.9444487275	-21.85496794	-4.49162171915	-3.340	11	.007
Pair 2	M Infraspinatus Y – T Infraspinatus Y	-5.779018250	13.983220137	4.036607955	-14.663532456	3.105495956	-1.432	11	.180
Pair 3	M Mid Trap Y – T Mid Trap Y	-17.449632833	24.041830405	6.940278628	-32.725083101	-2.174182566	-2.514	11	.029
Pair 4	M Low Trap y – T Low Trap	-14.104541167	18.012674079	5.199811114	-25.549248265	-2.659834069	-2.713	11	.020



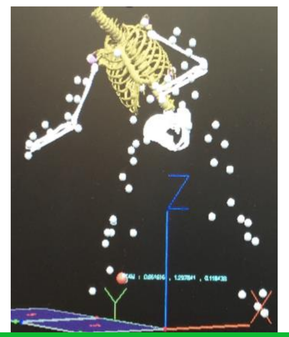


RESULTS SUMMARY

- A Pearson correlation coefficient was calculated for the relationship between participant's for the maximum muscle activation achieved (normalized with % MVIC) for the posterior deltoid, infraspinatus, middle trapezius, and lower trapezius during the traditional and modified version of the cable retraction with ER exercise. The researchers found a strong positive correlation for peak muscle activation of the posterior deltoid ($r(10) = .913$, $p < .001$), infraspinatus ($r(10) = .749$, $p < .001$), middle trapezius ($r(10) = .765$, $p < .001$), and lower trapezius ($r(10) = .850$, $p < .001$) when comparing the two exercises, indicating a significant relationship between peak muscle activation of these four muscles during the two exercises. Therefore, both exercises produce nearly the same peak activation of the four muscles being studied.
- A paired-samples *t* test was calculated to compare the mean difference of the peak %MVICs of the muscles being studied during each exercise. The mean difference peak %MVIC between the two exercises was .0749 (*sd* = .5527) for the posterior deltoid, .4329 (*sd* = 1.174) for the infraspinatus, .02914 (*sd* = .7711) for the middle trapezius, and .08810 (*sd* = .3021) for the lower trapezius. These results indicate no significant difference between average peak muscle activation between the two exercises with the four muscles being studied.
- A paired-samples *t* test was calculated to compare the mean difference of the glenohumeral abduction angle of the peak muscle activity of the muscles being studied during each exercise. The angle of abduction was significantly less during the modified exercise for the posterior deltoid (13.17°, *sd* = 13.66°), middle trapezius (17.45°, *sd* = 24.04°), and lower trapezius (14.10°, *sd* = 18.01°).

CONCLUSION

- Based on the results, there were no significant differences present when comparing the exercises being tested, therefore; the researchers of this study deem that modifying the traditional exercise is unnecessary if the clinician is targeting the four muscles tested in this study. However, it may be beneficial to the submarine pitcher to perform the modified version of the exercise because it replicates the submarine throwing motion while still exercising the targeted muscles as efficiently and the traditional exercise.
- A significant difference was found in the angle of abduction in which peak muscle activation occurred for the posterior deltoid (13°), the middle trapezius (17°), and lower trapezius (14°). These three muscles achieved peak activation at a lower angle of abduction during the modified version of the exercises, than they did during the tradition version. This may warrant the utilization of this exercise because it allowed for peak muscle activation in a position that is less likely to cause subacromial impingement than the traditional exercise.
- Future research needs to be performed to determine the biomechanics and muscle activation patterns of the submarine pitcher to develop a better understanding of the physiological demands of this activity. This knowledge will aid clinicians in developing appropriate exercise programs and techniques to train theses athletes in a functional manner.



REFERENCES

DiGiovine, N., Jobe, F., Pink, M., & Perry, J. (1992). An electromyographic analysis of the upper extremity in pitching. Journal of Shoulder and Elbow Surgery, 1, 15-25.
Kendall, F., McCreary, E., & Provance, P. (1993). *Muscles: Testing and function*. Baltimore, MD: Williams and Wilkins.
Paine, R., Voight, M. (2013). Invited clinical commentary the role of the scapula. The International Journal of Sports Physical Therapy, 8, 617-629.
Truedson, T., Sexton, P., & Pettitt, R. (2012). Unconventional baseball pitching styles, part 1: Biomechanics and pathology. *International Journal of Athletic Therapy & Training, 17*, 35-39.
Truedson, T., Sexton, P., & Pettitt, R. (2012). Unconventional baseball pitching styles, part 2: Upper extremity rehabilitation. *International Journal of Athletic Therapy & Training, 17*, 40-44
10- camera Oqus 300 1.3MP infrared motion capture system (Qualisys, Gothenburg, Sweden) and Noraxon electromyography plug-in system (Scottsdale, Arizona)
SPSS software (Version 20.0. Armonk, NY: IBM Corp)