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AUTOGENIC INHIBITION VERSUS RECIPROCAL INHIBITION MUSCLE ENERGY TECHNIQUES' EFFECT ON SWIMMING PERFORMANCE IN SWIMMERS WITH SCAPULAR DYSKINESIS – RCT

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ABSTRACT

Objective: To compare the effects of AI-MET and RI-MET on key swimming performance parameters in swimmers diagnosed with scapular dyskinesis.
Methodology: A randomized controlled trial (two-arm parallel study) with two intervention groups (A and B) was conducted at various swimming centres involving a sample size of 34 participants, which was calculated using the Harvard sample size calculator. Participants who can swim at least four times per week with a freestyle swimming stroke and a positive scapular dyskinesis test were included in the study. However, participants who had any recent trauma to the shoulder, shoulder pain, or any recent history of shoulder surgery were excluded from the study. The study employed a non-probability, purposive sampling technique. Video analysis software assessed baseline outcomes. The intervention protocol was conducted for 3 weeks, consisting of a total of 12 sessions, held 4 times per week, each lasting between 8 to 14 minutes.
Results: The average age of the study participants was 19.7 ± 1.3 years. There were significant improvements within groups, with p-values <0.05 in the variables stroke velocity, stroke rate, and cycle time at the 3-week follow-up after 12 treatment sessions. After 3 weeks, no significant differences were observed between the groups for any of the measured variables with a p-value of >0.05.
Conclusion: Both Autogenic inhibition muscle energy techniques and Reciprocal inhibition muscle energy techniques were equally effective in enhancing stroke velocity, rate, and cycle time among swimmers with scapular dyskinesis. However, there is no significant difference in effectiveness between the two techniques.
Clinical Trial Number: [NCT06202391]

INTRODUCTION:

Swimming, a globally popular sport, inherently places substantial biomechanical stress on the musculoskeletal system, particularly the shoulder joint. The repetitive overhead movements characteristic of swimming strokes render athletes susceptible to various shoulder pathologies, collectively often referred to as 'swimmer's shoulder' [1]. A significant contributor to shoulder dysfunction and pain in overhead athletes, including swimmers, is scapular dyskinesis [2]. This condition is characterized by an observable change in the normal resting position or dynamic motion of the scapula during coupled scapulohumeral movements [3].

The scapula plays a key role in facilitating efficient upper extremity kinematics and maintaining glenohumeral joint stability [4]. Optimal scapular positioning and movement are important for effective stroke mechanics, contributing to both enhancing performance and preventing injuries in swimmers [5]. Altered scapular kinematics, a characteristic of dyskinesis, can lead to impingement syndromes, rotator cuff pathologies, and overall diminished athletic performance [6]. While the prevalence of scapular dyskinesis in asymptomatic overhead athletes has been reported to be as high as 54% [7], its early diagnosis and appropriate management in swimmers are critical to prevent progression and mitigate injury risk.

Muscle Energy Techniques (METs) are osteopathic manipulative treatments that use a patient's muscle contractions to achieve specific therapeutic goals, such as increasing range of motion, reducing hypertonicity, and improving muscle function [8]. Among the various MET approaches, Autogenic Inhibition Muscle Energy Technique (AI-MET) and Reciprocal Inhibition Muscle Energy Technique (RI-MET) are commonly used. AI-MET leverages the Golgi tendon organ reflex, where sustained isometric contraction of a muscle leads to its subsequent relaxation, thereby increasing its extensibility. Conversely, RI-MET uses Sherrington's Law of Reciprocal Inhibition, whereby the contraction of an agonist muscle leads to the relaxation of its antagonist, thereby facilitating an increased range of motion [9]. These techniques have shown promising results in addressing musculoskeletal imbalances and improving functional outcomes in various populations [10].

Given the prevalence of scapular dyskinesis in swimmers and its potential impact on performance and injury risk, investigating effective therapeutic interventions is critical. This study aimed to compare the effects of AI-MET and RI-MET on key swimming performance parameters in swimmers diagnosed with scapular dyskinesis. By evaluating the comparative effectiveness of these two MET approaches, this research sought to contribute to the evidence base guiding rehabilitation strategies for this specific athletic population, ultimately enhancing performance and reducing the incidence of shoulder-related injuries.

Methodology

This study was designed as a randomized controlled trial with a two-arm parallel group design. Ethical approval was obtained from the Ethical Review Committee of Foundation University Medical College, and the trial was registered under Clinical Trial Number NCT06202391. The study was conducted from October 2023 to April 2024, with data collection occurring at various swimming centers across Rawalpindi and Islamabad. Participants provided informed consent prior to enrollment.

A total of 34 participants were recruited using a non-probability purposive sampling technique. The sample size was determined using the Harvard sample size calculator, based on a 0.05 significance level, 80% power, and an effect size of 0.8. Inclusion criteria comprised swimmers who trained at least four times per week, used the freestyle swimming stroke, and presented with a positive scapular dyskinesis test. Exclusion criteria included individuals with recent shoulder trauma, shoulder pain, a recent history of shoulder surgery, or fractures within the preceding six months, as well as those involved in other competitive sports. Eligible participants were randomly assigned to one of two intervention groups using a sealed envelope method: Group A (Autogenic Inhibition Muscle Energy Technique, AI-MET) or Group B (Reciprocal Inhibition Muscle Energy Technique, RI-MET). Both MET protocols targeted commonly shortened muscles implicated in scapular dyskinesis, including the upper trapezius, levator scapulae, pectoralis major, and

latissimus dorsi [11].

The AI-MET protocol involved 3–5 repetitions of 30–50% maximal voluntary isometric contraction of the target muscle, held for 5–10 seconds, followed by a 5-second rest and a 20–30 second passive stretch. The RI-MET protocol followed a similar structure, but involved isometric contraction of the antagonist muscle to the target muscle. Each participant underwent 12 treatment sessions over a period of three weeks, with four sessions per week, adhering to the FITT (Frequency, Intensity, Time, Type) principle. Each session lasted between 8 to 14 minutes.

Swimming performance was assessed by recording the total swim time (ST) over a 25-meter front crawl. A wall-mounted camera positioned 10 meters from the pool was used for video analysis. Prior to testing, swimmers completed a standardized 15-minute warm-up and were instructed to perform the 25-meter swim at maximum effort. Performance initiation was signaled by a whistle. Stroke parameters were subsequently analyzed using specialized video editing software. All collected data were securely stored on a password-protected laptop, accessible only to the primary researcher.

Scapular dyskinesis was diagnosed using the Scapular Dyskinesis Test (SDT). Participants performed overhead arm movements while holding weighted dumbbells (3 lb. or 5 lb., adjusted based on body weight) and were observed from a posterior view. Dyskinesis was identified by the presence of motion abnormalities such as dysrhythmia (e.g., excessive elevation, stumbling, or rapid lowering) or winging (posterior displacement of the scapula) [12]. Scapular movement was classified as normal or dyskinetic based on these observations.

Data were entered and analyzed using SPSS version 26.0. Given the relatively small sample size (n=34), the Shapiro-Wilk test was employed to assess the normality of data distribution. Descriptive statistics for quantitative variables were reported as mean ± standard deviation, median, and interquartile range (IQR), depending on the data distribution. Qualitative variables were presented as frequencies and percentages. Between-group comparisons were conducted using the Mann-Whitney U test, while within-group pre- and post-intervention comparisons were analyzed using the Wilcoxon signed-rank test. The Shapiro-Wilk test revealed non-normal distributions for stroke length, cycle time, and total strokes in the autogenic inhibition MET group ($p < 0.05$), which justified the use of non-parametric tests for subsequent analyses.

Results

The average age of the study participants was 19.7 ± 1.3 years. The detailed results of the between-group and within-group comparisons are presented in Table 1 and 2, respectively.

Table 1: Differences between groups

Variables		Group A	Group B	P value
		Median (IQR)	Median (IQR)	
Stroke Velocity	**Baseline**	1.40(0.45)	1.46(0.36)	0.708
	After three weeks	2.10(0.50)	2.03(0.51)	0.375
Stroke rate	**Baseline**	3.50(1.02)	3.50(0.96)	0.919
	After three weeks	5.20(1.20)	5.00(1.07)	0.610

Stroke Length	**Baseline**	24.3(1.30)	24.8(0.40)	0.092
	After three weeks	24.6(0.70)	24.9(0.9)	0.322
Total Strokes	**Baseline**	0.98(0.02)	0.98(0.02)	0.658
	After three weeks	0.99(0.01)	0.98(0.02)	0.658
Cycle time	**Baseline**	17.10(5.30)	17.80(4.70)	0.812
	After three weeks	11.50(2.85)	12.30(2.80)	0.306

Table 1 indicates no statistically significant differences between Group A and Group B for any measured variables at baseline or after three weeks of intervention ($p > 0.05$).

Table 2: Differences in variables within groups

Variables	Groups	Variable Median (IQR)		P Value
		Stroke velocity - Baseline Assessment	**Stroke velocity - Terminal Assessment**	
Stroke Velocity	**Group A**	1.40(0.45)	2.10(0.50)	<0.001*
	Group B	1.46(0.36)	2.03(0.51)	<0.001*
Stroke Rate	**Group A**	3.50(1.02)	5.20(1.20)	0.001*
	Group B	3.50(0.96)	5.00(1.07)	<0.001*
Stoke Length	**Group A**	24.3(1.30)	2.10(0.50)	0.271
	Group B	1.46(0.36)	2.03(0.51)	0.485
Total Strokes	**Group A**	0.98(0.02)	0.99(0.01)	0.303

	Group B	0.98(0.02)	0.98(0.02)	0.857
Cycle Time	**Group A**	17.10(5.30)	11.50(2.85)	0.001*
	Group B	17.80(4.70)	12.30(2.80)	<0.001*

Table 2 demonstrates statistically significant improvements within both Group A and Group B for stroke velocity, stroke rate, and cycle time from baseline to post-intervention ($p < 0.001$). However, stroke length and total strokes did not exhibit significant changes in either group ($p > 0.05$). These findings suggest that both AI-MET and RI-MET effectively improved performance metrics related to speed and efficiency but had a limited impact on stroke length and total stroke count.

Discussion

This study aimed to compare the effects of Autogenic Inhibition Muscle Energy Technique (AI-MET) and Reciprocal Inhibition Muscle Energy Technique (RI-MET) on swimming performance in individuals with scapular dyskinesis. The findings indicate that both AI-MET and RI-MET interventions led to significant within-group improvements in stroke velocity, stroke rate, and cycle time after a 3-week intervention period. This demonstrated the effectiveness of both techniques in enhancing key performance indicators in swimmers with scapular dyskinesis. Significantly, no statistically significant differences were observed between the two groups for any measured variables, suggesting that both techniques are comparably effective.

These results align with the broader understanding of METs as effective modalities for improving muscle flexibility, reducing pain, and enhancing function [8]. The observed improvements in stroke velocity, rate, and cycle time suggest that METs, by addressing underlying MSK imbalances associated with scapular dyskinesis, can positively impact the efficiency and speed of swimming strokes. This contrasts with some previous research on other stretching methods, such as static or proprioceptive neuromuscular facilitation (PNF) stretching, which have occasionally been associated with an acute decline in athletic performance [14]. The distinct mechanisms of action of METs, involving active muscle contraction and post-isometric relaxation, may contribute to their more favourable impact on performance metrics.

Interestingly, our study did not find significant improvements in stroke length or total strokes. This outcome requires further discussion, particularly when compared to studies that have reported changes in stroke length post-training interventions. For instance, Girold et al. (2012) observed a significant decline in stroke length accompanied by an increase in stroke rate in competitive swimmers, which they attributed to specific sprint and weight training programs [15]. The discrepancy between our findings and those of Girold et al. may stem from differences in the intervention goals. While their study focused on general training adaptations, our intervention specifically targeted scapular muscle function through METs. It is plausible that while METs optimize the mechanics of individual strokes by improving muscle coordination and efficiency (reflected in improved stroke rate and cycle time), they may not directly influence the biomechanical factors that guide maximal stroke length, such as overall limb propulsion or body position, to the same extent.

Our findings regarding the improvement in stroke rate and its association with increased swimming speed are consistent with the work of Escobar et al. (2018), who reported that an increased stroke rate enhances

swimming speed and coordination in elite freestyle swimmers [16]. While Escobar et al. considered a broader range of variables, including stroke technique, swimming environment, and gender, our study specifically focused on the impact of METs in a population with scapular dyskinesis. The parallel observations reinforce the perspective that optimizing stroke rate is a critical determinant of swimming velocity and that interventions addressing underlying musculoskeletal limitations, such as scapular dyskinesis, can contribute to this optimization.

Comparing our results with studies focusing on demographic factors or different conditions provides further context. For example, Dormehl et al. (2019) explored the effects of age, gender, and race distance on stroke parameters in sub-elite adolescent swimmers, revealing significant differences based on these demographic variables [17]. Our study, by design, did not explicitly consider these demographic factors, focusing instead on the direct impact of MET interventions on performance parameters in a specific clinical population. This highlights the importance of contextualizing research findings within their specific study designs and objectives. While demographic factors undoubtedly influence swimming performance, our study demonstrated the effectiveness of targeted interventions independent of these broader variables.

Furthermore, a comparison with Muhammad Osama's (2021) study on the effects of AI-MET and RI-MET on isometric muscle strength in individuals with mechanical neck pain revealed both commonalities and distinctions [18]. Osama reported substantial improvements in pain and isometric muscle strength, with AI-MET showing superior outcomes. In contrast, our study found no significant difference between AI-MET and RI-MET in improving swimming performance parameters in swimmers with scapular dyskinesis, although both techniques demonstrated significant within-group improvements. This divergence highlighted the importance of considering the specific patient population and the nature of the condition being studied. Mechanical neck pain and scapular dyskinesis represent distinct MSK issues with potentially different responses to METs. The underlying pathology and biomechanical considerations may influence the observed outcomes, emphasizing the need for adjusted interventions based on the specific MSK issue being addressed.

The study by Noto-Bell et al. (2012) investigated the application of MET with post-isometric relaxation (PIR) to improve ankle plantarflexion and enhance flutter kick performance in young competitive swimmers, providing another comparative perspective [19]. While Noto-Bell et al. focused on lower extremity mechanics and MSK function, our study concentrated on upper extremity performance variables related to stroke mechanics. Both studies, however, demonstrated the positive impact of METs on athletic performance, albeit in different anatomical regions and with different outcome measures. This broader consistency suggested the versatility and potential applicability of METs across various aspects of athletic performance enhancement and injury prevention.

Conclusion

Both AI-MET and RI-MET are effective interventions for improving key swimming performance parameters, specifically stroke velocity, stroke rate, and cycle time, in swimmers with scapular dyskinesis. The absence of a statistically significant difference between the two techniques suggested that both can be equally valuable tools in the rehabilitation and performance improvement of this athletic population. These findings highlighted the importance of addressing scapular dyskinesis as a contributing factor to suboptimal swimming mechanics and highlighted the application of METs in this context. Future research could explore the long-term effects of these interventions, investigate their impact on other performance metrics, and consider the integration of METs with other training modalities to optimize outcomes for swimmers.

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