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Original Research Article

Evaluation of Scapular Dynamics in Sports Trainees

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ABSTRACT

Background: The scapula provides stability and mobility for efficient upper-limb movement. Optimal scapular kinematics are essential for efficient force generation and injury prevention. Sports trainees, particularly those involved in sports requiring repetitive or high-intensity shoulder movements, are susceptible to injuries and performance limitations if associated with aberrant scapular mechanics. Understanding the intricacies of scapular dynamics is essential for designing tailored training interventions that enhance athletic performance.

Rationale and objectives: Previous research has emphasized the need for sports-specific training protocols. The measurement of scapular rotation has gained significant attention. Evaluating asymmetries in scapular dynamics across various sports trainee populations is a step forward for the need for tailored interventions and injury prevention strategies in preventing injury and planning better exercise programs. The study uses a PALM meter for the measurement of scapular rotation.

Methodology: 40 Subjects 19 to 24 years old from the sports authority of Andhra Pradesh, India, were studied after obtaining written informed consent. Scapular rotation measured in a neutral and with hands on the hip position. Root of the scapula (RSS), inferior angle of the scapula (IAS), and spinous processes (Sp) of C7 to T8 are taken as the anatomical landmarks. Measurements of scapular position taken in two arm positions: shoulder neutral, hands on hip. A right-angle triangle created by dropping a perpendicular line from the scapula's root to intersect the horizontal line between the scapula's inferior angle and the thoracic spine's closest spinous process (IAS-Sp). The hypotenuse represents the distance IAS to RSS, while the side opposite the angle è is the distance IAS-Sp minus RSS-Sp. A positive result indicates upward scapular rotation, while a negative result indicates downward scapular rotation.

Results and Conclusion: This cross-sectional study revealed variations in scapular rotation and the distances from spinous processes in the scapular position in neutral and hands-on Hip positions from right to left and male to female. Further studies are required to understand scapular rotation variations concerning various sports involving overhead activity, heavy weight lifting, endurance sports and anatomical variations, muscle activation patterns, or task demands.

KEYWORDS: scapular rotation, sports trainees, shoulder movements, scapular mechanics, athletic performance.

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INTRODUCTION

Analysis and evaluation of the human shoulder complex is crucial for various sports disciplines, with the scapula as its core[1]. Accurate measurement of scapular rotation is critical for understanding and improving

athletic performance[2].

Understanding scapular rotation is critical for peak athletic performance and substantially influences injury prevention and recovery [3]. Sports practitioners may adapt rehabilitation programs to improve functional recovery and reduce the likelihood of recurring injuries by recognizing and correcting abnormalities in scapular mechanics early on[3]. Conventional measuring techniques, such as goniometry, often fail because of a lack of accuracy in capturing scapular motion[2].

A fundamental change has occurred in the measurement of scapular rotation in recent years, from subjective assessments to more objective modalities. Tools like the PALM (PaLpationMeter) meter have allowed researchers to measure and record scapular motion in real-time, more accurately depicting distances and angulations during upper limb tasks[4]. The palpation meter (PLAM) is a reliable mechanical device used in Physical examinations by professionals like therapists, physicians, surgeons, and technicians[5]. It measures the distance and angle between bony landmarks as they are palpated. The PALM's popularity is due to its simplicity and reliability. Its accuracy is achieved through a patented combination of palpating and measuring simultaneously[6].

The PALM provides objective readings of their relationship. Scapular rotation was measured on both sides (left and right) in a neutral sitting position and hands-on Hip position[7]. This study aims to study the variability of scapular rotational asymmetry and the applicability of the Palm meter in detecting upward and downward scapular rotation.

METHODS

A Cross-sectional Observational study was conducted at the sports authority of Andhra Pradesh, Vijayawada, India, in association with Acharya Nagarjuna University after ethical approval. 40 trainees of various sports (20 male and 20 female) between the ages of 18 and 25, without any clinical complaints, were considered for the study. Each subject was explained about the study process, and written informed consent was taken prior to the study.

The study involved participants seated on a chair with their shoulders exposed, hips and knees at 90 degrees of flexion, and adopting a relaxed posture to eliminate leg length discrepancies and reduce the chance of syncopal episodes. Measurements of the scapular position were taken in two arm positions: shoulder neutral and hands on hips in the coronal plane. The participant was asked to maintain this position actively. Measurements were taken three times, and the average was taken as a record. The participant rested the arm by the side between each measurement to avoid fatigue effects.

The examiner repeatedly palpated anatomical landmarks, such as the inferior angle of the scapula (IAS), the root of the spine of the scapula (RSS), and the spinous process of the thoracic spine (Sp). The distances were measured with the PALM mater and the analog inclinometer on the PALM guaranteed the horizontal distance[8]. The distances between the inferior angle of the scapula and the closest horizontal spinous process of the thoracic spine (IAS-Sp), the root of the scapula's spine and the closest horizontal spinous process of the thoracic spine (RSS-Sp), and the inferior angle of the scapula and the root of the scapula (RSS-IAS) were measured (Figure 1). The PALM inclinometer was verified to ensure it was centered at 0 in the vertically aligned position before data collection started.

The scapula rotation angle was computed using the distances IAS-Sp, RSS-Sp, and IAS-RSS. (Figure, 2) illustrates how to make a right-angle triangle by lowering a perpendicular line from the root of the spine of the scapula (RSS) to meet the horizontal line between the inferior angle of the scapula and the nearest spinous process of the thoracic spine (IAS-Sp). The distance between RSS and IAS is the hypotenuse. The distance IAS-Sp minus RSS-Sp is the side opposite the angle θ (specified as the angle between the hypotenuse and the vertical) and the vertical. To determine the angle that may be used. The degree of upward scapular rotation is

indicated by a positive result, while the degree of downward scapular rotation.

$$\sin\theta = \frac{Opposite}{Hypotenuse}$$

RESULTS AND DISCUSSION

A total of 40 sports trainees (Female 20, Male 20) were included in the study. The age for females mean±SD 21.3±1.75 and male 21.2±1.6. The minimum age is 19 for both groups, and the maximum is 24 for both groups. There is no statistically significant difference in age between the two groups.

The table 1 shows descriptive statistics of left (Lt)and right (Rt) side scapular dynamics in females and males in a neutral position(N) and hands-on HIP (H) position. It includes the mean and standard deviation. All three measurements (IAS to Sp Lt N, RSS to Sp Lt N, and IAS to RSS Lt N) are higher in males than females. This suggests that there is greater variability in the scapular dynamics in males than in females. Overall, the table suggests that there are differences in the left and right side scapular dynamics in both positions between males and females, with males having higher mean and standard deviation values and greater variability.

Summary of the descriptive statistics for scapular rotation angles (Table 2), Mean±SD values: Angles are generally higher in the hands-on hip (H) position compared to the neutral (N) position. Angles are slightly higher on the right side than on the left. Standard deviations: Variability is similar across all measures. Right H has the widest range (0.2638), while Left N has the narrowest (0.2670).

These differences between Angle N and Angle H for both the left and right sides suggest a postural influence on scapular rotation.

The null hypothesis of the paired samples t-test is that there is no difference between the means of the two groups. The alternative hypothesis is that there is a difference between the means of the two groups. The results of a paired samples t-test compare the means of two measures: Angle Lt N and Angle Rt N, Angle Lt H, and Angle Rt H. Cohen's d is a measure of the effect size of the difference between the means of the two groups. Cohen's d of 0.2 is considered a small effect size, 0.5 is considered a medium effect size, and 0.8 is considered a large effect size. The p-values for both Angle Lt N and Angle Rt N are greater than 0.05. This means that there is not enough evidence to reject the null hypothesis and conclude that there is a statistically significant difference between the means of Angle Lt ' and Angle Rt N, or between the means of Angle Lt H and Angle Rt H. In addition, Cohen's d values for both Angle Lt N and Angle Rt N are less than 0.2. This suggests that even if there is a difference between the means of the two groups, it is a small effect size. Both Angle Lt N vs. Angle Lt H ($p = 0.022$) and Angle Rt N vs. Angle Rt H ($p < 0.001$) show significant differences, indicating that scapular rotation angles are reliably different between neutral and hands-on-hip positions. The medium effect size for the left side ($d = -0.768$) and large effect size for the right side ($d = -1.581$) suggest meaningful differences, especially on the right. This finding suggests that Scapular Rotation Angles Increase in the Hands-On-Hip Position: Mean angles are consistently higher i

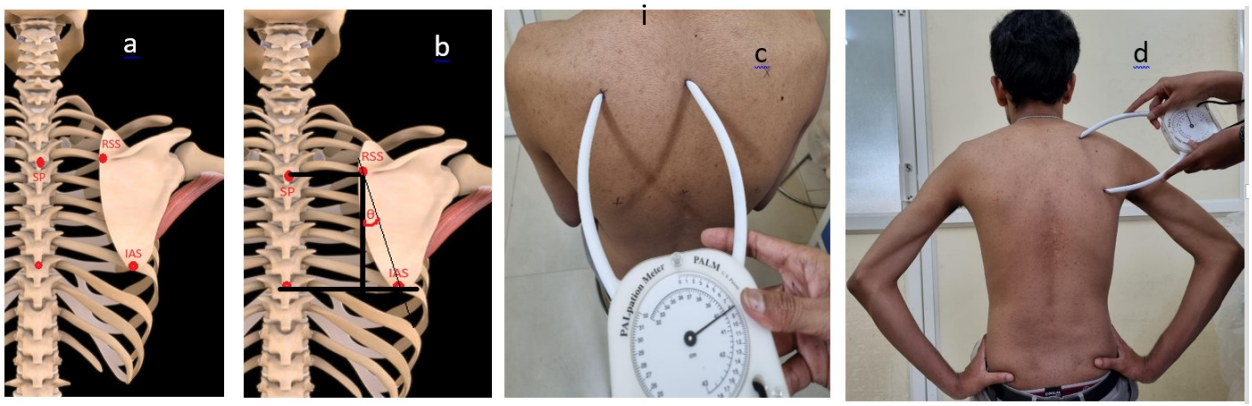

Fig. 1: Scapular dynamics: a) landmarks b) rotation angle measurement c) neutral sitting position d) hands-on hip position.

Table 1: Descriptive results of distance measures of scapula.

Measure	Gender	M±SD Lt	M±SD Rt		Measure	M±SD Lt	M±SD Rt
IAS to Sp N	F	6.17±0.59	7.27±0.99		IAS to Sp H	7.30±0.75	7.47±1.4
	M	8.67±1.84	8.9±1.78			8.17±2.05	9.37±2.09
RSS to Sp N	F	6.10±0.72	6.40±0.79		RSS to Sp H	5.87±0.88	5.87±0.67
	M	7.77±1.38	7.93±1.49			7.00±1.39	7.37±1.53
IAS to RSS N	F	9.430.67	9.50±0.57		IAS to RSS H	9.57±0.68	10.10±0.74
	M	11.77±1.52	11.97±1.70			12.07±1.51	12.40±1.59

Table 2: Scapular rotation angle of left and right side in neutral and hands on hip position.

Measure	Gender	M±SD Lt		Measure		P	Cohen's d
Angle Lt N	0.0812	0.0407±0.081		Angle Lt N	Angle Rt N	0.092	-0.532
Angle Rt N	0.0499	0.0862±0.0499		Angle Lt H	Angle Rt H	0.228	-0.368
Angle Lt H	0.0625	0.1235±0.062		Angle Lt N	Angle Lt H	0.022	-0.768
Angle Rt H	0.0874	0.1620±0.087		Angle Rt N	Angle Rt H	< .001	-1.581

Note. H_a $\mu_{\text{Measure 1 - Measure 2}} \neq 0$

n the H position compared to the N position for both sides. This suggests that postural changes associated with hands on hips influence scapular rotation. Right Side Exhibits More Pronounced Effect: Larger t-statistic, smaller p-value, and larger effect size for Angle Rt N vs. Angle Rt H indicate a stronger difference on the right side.

CONCLUSION

Overall, this updated analysis provides more compelling evidence for a difference between Angle N and Angle H in both left and right scapular dynamics, with the right side demonstrating a more pronounced effect. males having more variability than females. Understanding these measurements clinically is crucial for interpreting their implications in sports trainees. Further investigation might explore the potential causes of this asymmetry. Postural Influence on Scapular Dynamics findings highlight the importance of considering posture when assessing or addressing scapular function. Potential Clinical or Research Applications should aim to optimize scapular mechanics for pain management, injury prevention, or performance enhancement for tailored therapeutic interpretations and applications. Further Investigation on Exploring factors contributing to the observed differences, such as anatomical variations, muscle activation patterns, or task demands, could provide valuable insights.

ABBREVIATIONS

PALM - PaLpation Meter
IAS - inferior angle of the scapula
RSS - Root of the scapula
Sp - spinous processes
IAS-Sp-Distance between IAS to the horizontal corresponding Sp
RSS-Sp - Distance between RSS to the horizontal corresponding Sp
IAS - RSS Distance between IAS to RSS
Lt - Left
Rt - Right
N - Neutral sitting position
H - Hands-on hip position
(sin Θ) - Angle Scapular Rotation Angle

Conflicts of interest: None

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