

Scapular dyskinesis: Biomechanics, diagnosis, and rehabilitation approaches

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Abstract

Scapular dyskinesis refers to abnormal movement or positioning of the scapula, disrupting shoulder mechanics and contributing to dysfunction and pain. It is commonly caused by muscle imbalances, nerve injuries, or repetitive overhead activities, with athletes and individuals engaged in such activities being particularly at risk. Diagnostic tools, such as the Scapular Assistance Test (SAT) and Scapular Retraction Test (SRT), assess scapular motion abnormalities and their contribution to shoulder dysfunction. Emerging technologies, including motion capture and digital biophotogrammetry, offer promising advancements for evaluation. Rehabilitation emphasizes strengthening scapular stabilizers (e.g., serratus anterior, lower trapezius), improving posture, and addressing muscle imbalances. Despite progress in treatment, challenges remain in optimizing diagnostic accuracy and long-term prevention. A comprehensive understanding of scapular biomechanics and evidence-based rehabilitation strategies is critical for effective management and future research.

Keywords: Biomechanics, muscle imbalance, rehabilitation, scapular dyskinesis, shoulder pain

Introduction

Scapular dyskinesis is a condition characterized by altered kinematics of the scapula, which can disrupt the scapulohumeral rhythm and lead to a range of shoulder pathologies, including impingement, rotator cuff tears, and adhesive capsulitis. The term originates from the Greek words “dys-” (change in) and “kinesis” (movement), signifying deviations in the scapula’s static or dynamic positioning during arm motion. These alterations result in diminished scapular retraction and posterior tilt while increasing protraction and internal rotation, thereby impairing shoulder function [1].

The scapula serves several critical roles: maintaining glenohumeral alignment, enhancing joint stability, and facilitating force transfer within the kinetic chain. Efficient

scapular motion is vital for optimal shoulder mechanics, especially during elevation and overhead movements [2]. This article reviews the biomechanics, diagnosis, and management of scapular dyskinesis, highlighting advancements in diagnostic technologies and rehabilitation strategies.

Biomechanics of scapular movement

The scapula has five degrees of freedom, allowing movement in two translational directions (protraction/retraction and elevation/depression) and three rotational planes (upward/downward rotation, internal/external rotation, anterior/posterior tilt). Each motion involves specific muscle groups:

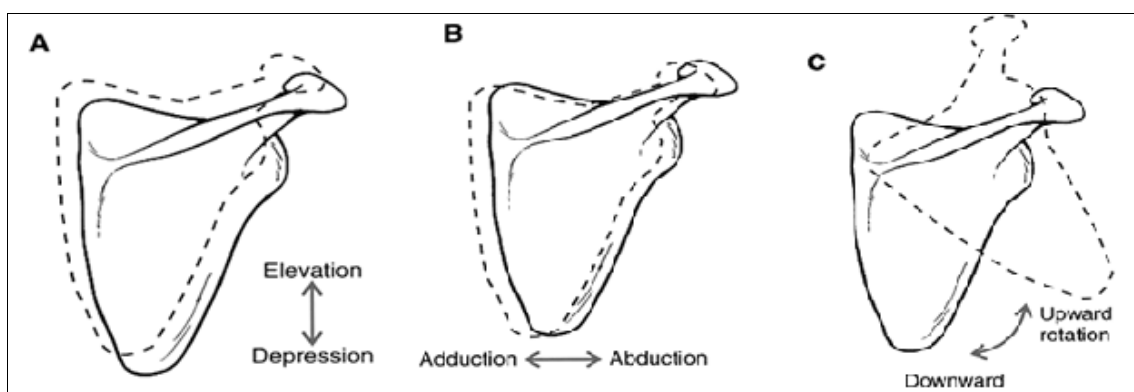


Fig 1: Scapular movements: (A) Elevation and depression (B) Abduction (protraction) and adduction (retraction) (C) Upward and downward rotation (Modified from Hamill 2015)

- **Elevation/Depression:** Upper trapezius and levator scapulae elevate the scapula, while lower trapezius and pectoralis minor depress it [3].
- **Protraction/Retraction:** Protraction is driven by the serratus anterior, while retraction involves the rhomboids and middle trapezius.
- **Rotational Motions:** Upward rotation, crucial for arm elevation, is achieved by the serratus anterior and trapezius, while downward rotation is controlled by the rhomboids and levator scapulae [4].

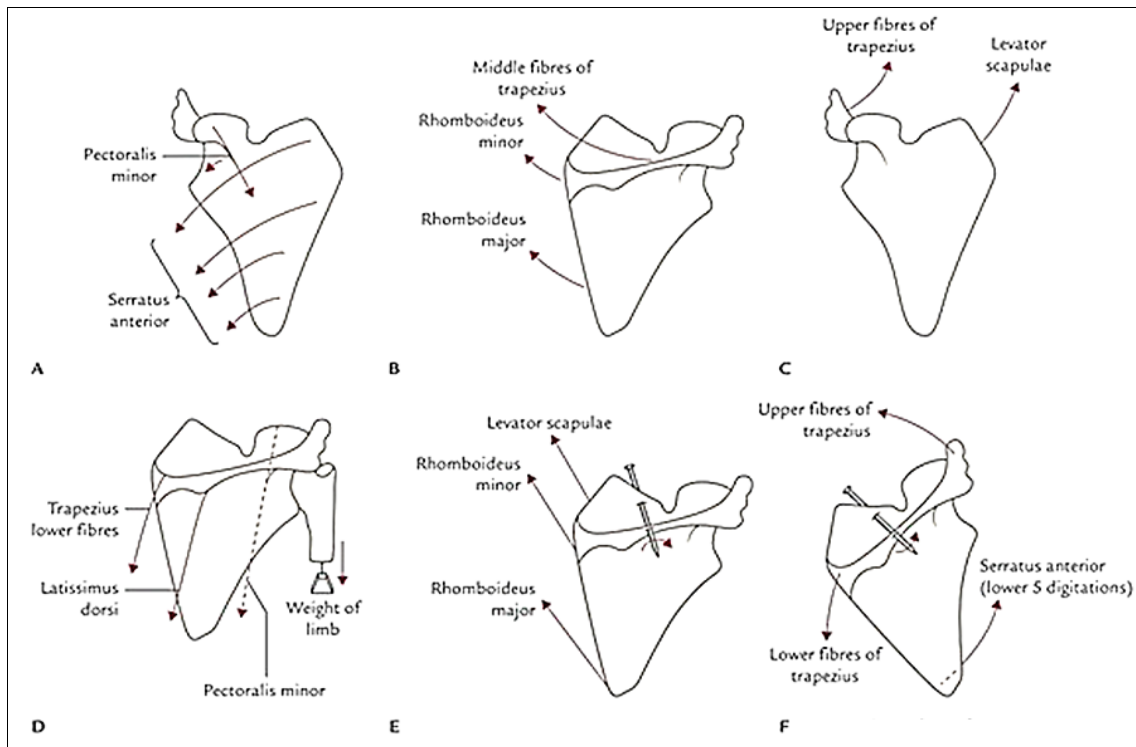


Fig 2: Muscles producing scapular movements: (A) Protraction (B) Retraction (C) Elevation (D) Depression (E) Downward rotation (F) Upward rotation (Modified from Hamill 2015)

Scapulohumeral rhythm describes the coordinated motion between the scapula and humerus during arm elevation, typically occurring at a ratio of 2:1 (glenohumeral to scapulothoracic motion). This rhythm ensures optimal joint mechanics and force distribution.

Etiology and Prevalence

Scapular dyskinesia arises from various factors, including:

- **Muscle imbalances:** Weakness or fatigue in the serratus anterior or lower trapezius disrupts scapular control [5].
- **Postural abnormalities:** Conditions like kyphosis and forward shoulder posture increase scapular protraction and anterior tilt [6].
- **Injuries:** Nerve damage (e.g., long thoracic nerve), clavicle fractures, or acromioclavicular joint injuries impair scapular motion.
- **Repetitive activities:** Overhead sports, such as baseball or swimming, predispose athletes to scapular dyskinesia due to repetitive strain.

Prevalence is notably higher in athletes, with rates of 61% in overhead athletes compared to 33% in non-overhead athletes [7]. Additionally, elderly individuals exhibit higher rates of scapular dysfunction due to degenerative changes and muscle atrophy.

Implications in shoulder pathology

Scapular dyskinesia contributes to:

- **Impingement syndromes:** Excessive protraction reduces the subacromial space, increasing the risk of external impingement and rotator cuff tears [8].

- **Rotator cuff weakness:** Altered scapular positioning compromises dynamic stability, reducing muscle efficiency by up to 23% [9].
- **Increased humeral translation:** Dyskinesia exacerbates anterior capsular strain, contributing to micro-instability [10].

Diagnostic approaches

Clinical assessment

Visual observation remains a primary diagnostic tool. Movements such as shoulder flexion, abduction, and scaption are evaluated for asymmetry, winging, or stuttering. The Lateral Scapular Slide Test quantifies scapular positioning, with a difference >1.5 cm indicating dyskinesia [11].

Advanced tools for scapular dyskinesia evaluation

Advanced diagnostic tools are crucial for accurately identifying and assessing scapular dyskinesia, guiding effective treatment strategies. These tools include:

1. **Scapular Assistance Test (SAT):** This clinical test evaluates the impact of manually correcting scapular motion during arm movement. The examiner assists scapular upward rotation and posterior tilt to simulate proper biomechanics. A reduction in symptoms, such as pain or improved range of motion, suggests that scapular dyskinesia is a contributing factor to the patient’s shoulder dysfunction.
2. **Scapular Retraction Test (SRT):** The SRT assesses the role of scapular stabilization in shoulder function. By manually stabilizing the scapula in a retracted position, the test evaluates improvements in rotator cuff

strength and reduction in impingement symptoms. This test highlights the significance of scapular control in optimizing rotator cuff mechanics ^[12].

3. **Digital motion analysis:** Advanced technologies like electromagnetic sensors and digital biophotogrammetry provide precise, quantitative kinematic data on scapular motion. These tools allow objective assessments, identifying abnormalities that may not be visible during clinical observation ^[13].
4. **Shoulder Symptom Modification Procedure (SSMP):** This stepwise approach systematically explores modifications in scapular alignment, thoracic posture, and humeral positioning. It helps clinicians determine specific interventions that reduce symptoms and improve movement efficiency, aiding in the design of tailored rehabilitation protocols ^[14].

These tools enhance diagnostic accuracy and inform targeted treatment strategies for scapular dyskinesis.

Current practices in rehabilitation intervention strategies

Effective rehabilitation for scapular dyskinesis involves a comprehensive approach that addresses muscular imbalances, restores scapular control, and improves scapulohumeral rhythm. The rehabilitation process typically progresses through three phases:

Acute Phase (0-3 Weeks)

- In this initial phase, the focus is on pain relief, inflammation reduction, and gentle mobilization ^[15, 16].
- Key techniques include ^[15, 17]:
 1. Stretching exercises for tight muscles, particularly the pectoralis minor and levator scapulae
 2. Gentle isometric exercises to activate scapular stabilizers
 3. Scapular mobilization techniques to improve joint mobility

Recovery Phase (3-8 Weeks)

- This phase emphasizes muscle activation and stabilization ^[15, 16].
- Techniques include ^[16, 17]:
 1. Closed-chain exercises such as wall push-ups and weight-bearing isometric extension exercises
 2. Dynamic arm elevation exercises with a focus on scapular stabilization
 3. Proprioceptive training to enhance neuromuscular control

Maintenance Phase (6-10 Weeks)

- The final phase focuses on functional integration and prevention ^[15, 16].
- Key components include ^[17, 18, 19]:
 1. Plyometric exercises to improve power and coordination
 2. Overhead presses and sport-specific drills to simulate functional activities
 3. Continued strengthening of scapular stabilizers, particularly the serratus anterior and lower trapezius

Throughout all phases, emphasis should be placed on proper scapular positioning and movement patterns. Conscious

correction and visual feedback have been shown to enhance scapular muscle activity and kinematics ^[18].

Emerging modalities such as kinesio taping and proprioceptive neuromuscular facilitation (PNF) techniques have shown promise in improving scapular control and muscle activation ^[19, 20]. Additionally, core strengthening exercises are often incorporated to improve overall body mechanics and reduce compensatory movements ^[17].

It's important to note that rehabilitation should be tailored to the individual's specific type of scapular dyskinesis and underlying causes ^[21]. Regular reassessment and progression of exercises based on the patient's response is crucial for optimal outcomes.

Conclusion

Scapular dyskinesis significantly impacts shoulder function and quality of life, particularly in athletes and individuals performing repetitive overhead activities. Comprehensive evaluation, including advanced diagnostic tools, facilitates accurate assessment. Tailored rehabilitation programs focusing on muscular rebalancing and functional integration are essential for recovery and injury prevention. Future research should explore innovative diagnostic technologies and long-term preventive strategies to optimize outcomes.

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