Managing the Hemiparetic Upper Extremity from the Proximal Perspective

Presented by:
C. Steve Childress, OT/L, C/NDT, CBIS
Jodi Renard, PT, DPT, C/NDT, CBIS

January 6, 2023

Classifying Level of Impairment

Hemiplegia of the Upper Extremity

Classifying Impairment Levels in Stroke

Hierarchical Properties of the Fugl-Meyer Assessment Scale Motor Function Sections

Twitchell[6]	Brunnstrom[7]	Fugl-Meyer et al[1]	Upper extremity	Lower extremity
Flaccid paralysis with areflexia	Stage 1 Flaccid paralysis			
Reflex activity returns/ spasticity develops	Stage 2 Development of minimal movement in synergies	Stage 1 Reflex activity	- Tendon reflexes	- Tendon reflexes
Voluntary movement in stereotyped flexor and extensor synergies/ spasticity is at maximal level	Stage 3 Voluntary movement synergy dependent	Stage 2 Voluntary movement in flexor and extensor synergies	- Flexor synergy - Extensor synergy	- Flexor synergy - Extensor synergy
Voluntary movement with breaking up of synergies/ spasticity is reducing	Stage 4 Some movements out of synergy	Stage 3 Voluntary movement partially independent of synergies	- Hand to lumbar spine - Shoulder flexion 0° - 90° - Pronation/supination (elbow 90°)	In sitting position - Knee flexion - Ankle dorsiflexion
	Stage 5 Movements almost independent of synergy	Stage 4 Voluntary movement independent of synergies	- Shoulder abduction 0° - 90° - Shoulder flexion 90° - 180° - Pronation/supination (elbow 0°)	In standing position - Knee flexion - Ankle dorsiflexion
Normal voluntary movement with normal speed and dexterity/ slight hyperactivity of the tendon reflexes	Stage 6 Normal movement with normal speed	Stage 5 Normal reflex activity	- Tendon reflexes (symmetry)	- Tendon reflexes (symmetry)
	Wrist	Wrist	- 5 items	
	Hand	Hand	- 7 items	
		Coordination No dysmetria or ataxia and normal speed	- Tremor - Dysmetria - Time	- Tremor - Dysmetria - Time

Crow, J. & Wel, Barbara. (2008). Hierarchical Properties of the Motor Function Sections of the Fugl-Meyer Assessment Scale for People After Stroke: A Retrospective Study. Physical therapy. 88. 1554-67. 10.2522/ptj.20070186.

Characterizing UE Hemiplegia Impairment

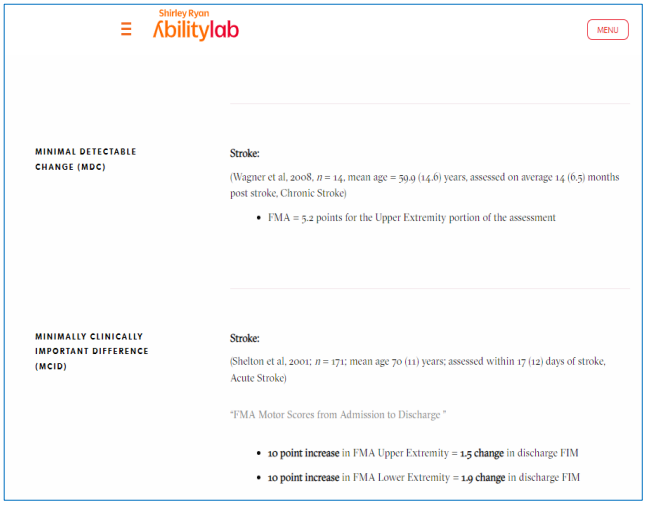
Childress UE Impairment Levels- Characteristics	
Severe Weakness - Postural Consequence	➢ Hypotonic presentation ➢ Little to no active movement proximally or distally. ➢ Sitting and standing postures affected by the global weakness of the arm
Severe Weakness – Minimal to no Postural Consequence	➢ Hypotonic or hypertonic presentation ➢ Thoracic and scapular postures are at or near target alignments ➢ Little to no active movement proximally or distally. ➢ Postural stability may be assisted by spasticity – muscular contraction relieves the heavy arm syndrome.
Proximal movement without Distal Function	➢ Partial Active movement of the Proximal UE –likely due to proximal synergy patterns (not always) ➢ Some but infrequent functional assist- • Can be helpful for donning shirts/coats, able to lift from surface and place to another, carry objects through use of pinning against body

Childress UE Impairment Levels- Characteristics	
Assistive Function User	➢ Some anti-gravity movement proximally, gross grasp and release are somewhat present distally. ➢ Can use affected UE for non-skilled tasks- unaffected performs higher level skills (carrying, holding, stabilizing object on counter/table).
Quasi-Skilled User	➢ Adequate active movement for reach in multiple planes, adequate distal movement for skilled prehensions. ➢ Multi-joint coordination emerging / present. (Wrist, elbow, forearm, shoulder have to interact with skill) ➢ Sophisticated prehension skills emerging / present. ➢ Highly dependent on thumb movements in multiple planes- functional arches of hand are on point! ➢ Some dominant hand functions might be resumed ie. Shaving/feeding- requires sophisticated prehension grasp with multi-joint coordination to perform motions.
In Hand Manipulator	➢ Skilled prehensions are intact, Able to adjust objects while holding it. ➢ Requires isolated finger movements independent of the other digits- arches and thumb are on point ➢ Moderate to even mild sensory impairments can prevent patients with excellent selective movement from achieving this level ➢ Might achieve dominant hand functions again (writing, typing, eating, shaving, musical instrument, athletics).
Distal User with Poor to Weak Proximal Movement – "The Unicorn"	➢ Distal skill can range greatly ➢ Even active elbow flexion can be helpful to allow hand to interact with objects. ➢ Don't give up on the proximal function for these patients

The Layers of Motor Activity Between the Fugl-Meyer and Brunnstrom's Stages

- Fugl Meyer and Brunnstrom stages require anti-gravity movement- (even in the earliest stages).
- To develop the muscle force requirements (strength) to stabilize the arm (long lever) in open chain, we have to address the layers of strength between what these outcome measures measure.
- FMA and Bruunstrom's phases- show advancement of ***SELECTIVE MOVEMENT***
  - Advancing past beginning phases (extensor and flexor synergies)
  - Higher phases require ACTIVE & ISOLATED movement patterns- ie) ER , Elbow Ext, Deltoid/RTC , Scapular force couples
    - If they have even traces of these fundamental components→ we have to find a way to strengthen these pre-requisite movements.
    - These need to simulate the ***NORMAL SYNERGIES*** of active reach
- Is it possible your patient is improving, but the outcome measures are not able to capture this progress…***YET!***

Detectable change using the FMA



- FMA measures the improvement in motor function ***OVER TIME.***
- Many studies using the FMA as their outcome measure are capturing this change at:
  - Initiation of the study
  - Termination of the study
- These studies are often measuring this change over a 6-month period.
- Your progress notes need to reflect the subjective/objective observations you are observing in their treatment progression.
  - Less physical assist, improved active movement, able to move in incline motion vs. horizonal, etc.

Developing Forward Reach

Role of posture, and how the muscles of the trunk, scapula, and glenohumeral joint(s) affect efficient reach or promote maladaptive movement strategies.

Phases of Reach: Sequencing Reach, Grasp and Manipulation skills

- Key Elements of UE Reach
  1. Visual Regard: Locating the Target
     - Coordination of Eye – Head movements
     - Essential in guiding movements of the hand
  2. Transport Phase: "Go get it"
     - Position of the hand sequence prior to reach away- linear vs. arc
     - Includes postural control
  3. Grasping
     - Hand shaping- Anticipatory (happens in the planning phase)
       - Size of the object
       - Position of the object
       - Anticipated weight of the object
     - Grip formation, Grasp and release.
  4. In Hand Manipulation Skills

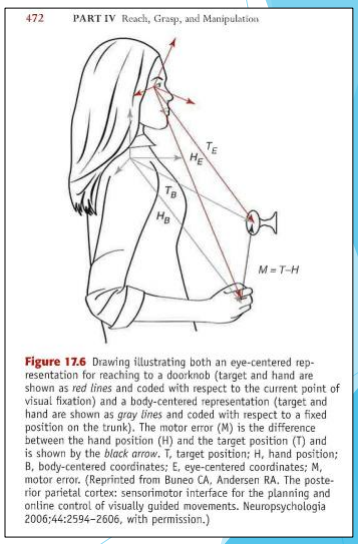


Figure 17.6 Drawing illustrating both an eye-centered representation for reaching to a doorknob (target and hand are shown as *red lines* and coded with respect to the current point of visual fixation) and a body-centered representation (target and hand are shown as *gray lines* and coded with respect to a fixed position on the trunk). The motor error (M) is the difference between the hand position (H) and the target position (T) and is shown by the *black arrow*. T, target position; H, hand position; B, body-centered coordinates; E, eye-centered coordinates; M, motor error. (Reprinted from Buneo CA, Andersen RA. The posterior parietal cortex: sensorimotor interface for the planning and online control of visually guided movements. Neuropsychologia 2006;44:2594–2606, with permission.)

Shumway-Cook. (2016). Normal reach, grasp, & Manipulation. In Motor control (5th ed., pp. 465-489). Wolters Kluwer Law & Business.

Reaching: A multi-system skill (sensory, motor, cognitive)

- Adaptation: Critical part of UE Function
  - Reaching movements vary greatly according to the goals and constraints of the task.
  - Feedforward control
  - Feedback control
- Reach: Acceleration and Deceleration:
  - Requires the coordination of concentric, eccentric, and isometric movements/muscles across multiple segments/joints of the body (pelvis, trunk, shoulder, elbow).
  - Pointing vs. grasping
    - Pointing: Arm acts as a unit
    - Reach and grasp: 2 separate phases/subcomponents.
      - Arm and Hand are controlled by separate areas of the brain.

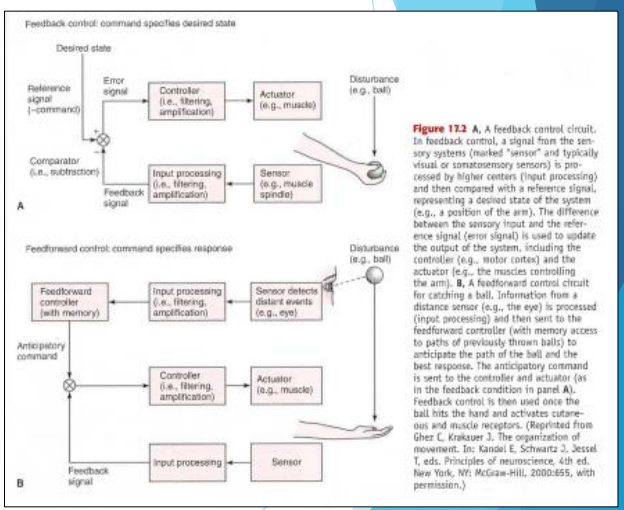


Figure 17.2 A, A feedback control circuit. In feedback control, a signal from the sensory systems (marked "sensor" and typically visual or somatosensory sensors) is processed by higher centers (input processing) and then compared with a reference signal, representing a desired state of the system (e.g., a position of the arm). The difference between the sensory input and the reference signal (error signal) is used to update the output of the system, including the controller (e.g., motor cortex) and the actuator (e.g., the muscles controlling the arm). B, A feedforward control circuit for catching a ball. Information from a distance sensor (e.g., the eye) is processed (input processing) and then sent to the feedforward controller (with memory access to paths of previously thrown balls) to anticipate the path of the ball and the best response. The anticipatory command is sent to the controller and actuator (as in the feedback condition in panel A). Feedback control is then used once the ball hits the hand and activates cutaneous and muscle receptors. (Reprinted from Ghez C, Krakauer J. The organization of movement. In: Kandel E, Schwartz J, Jessel T, eds. Principles of neuroscience, 4th ed. New York, NY: McGraw-Hill, 2000:655, with permission.)

Shumway-Cook. (2016). Normal reach, grasp, & Manipulation. In Motor control (5th ed., pp. 465-489). Wolters Kluwer Law & Business.

Feed-forward and feedback

The Beer Stein Experiment

Feed-forward and feedback

The Beer Stein Experiment

Phases to reach / grip in the transport phase of reach

1. Finger contact
2. Grip and load Force
3. Movement- load force is adequate
4. Grip force / load force decline – contact with the table

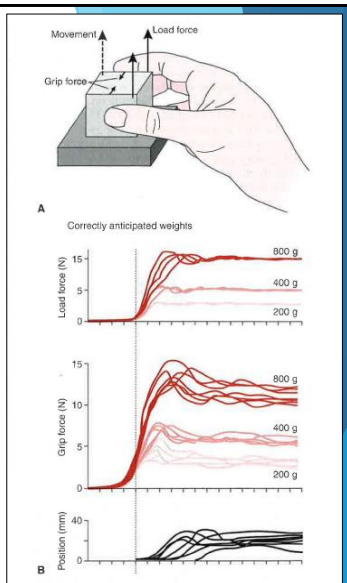


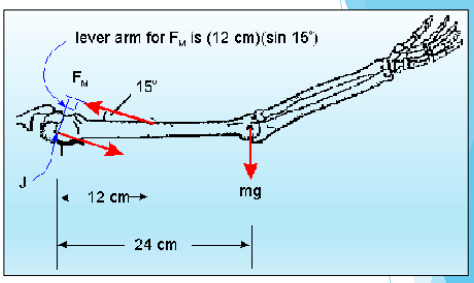
Figure 17.11 **A,** A subject lifts an object from a table that is instrumented with both grip force and load force detectors. **B,** The person knows the object's weight (200, 400, or 800 g) in advance, and thus, the forces used are appropriate for lifting the object, as you see in the three sets of traces (load force, grip force, and position) from multiple trials. Note that the grip force is scaled in proportion to the weight of the object so that the object doesn't slip. (Reprinted from Kandel ER, et al. Principles of neural science. 5th ed. New York, NY: McGraw Hill, 2013. Fig. 33-14, p. 758, with permission.)

The Weight of the UE for Function
The Conundrum of the Hemiplegic Arm

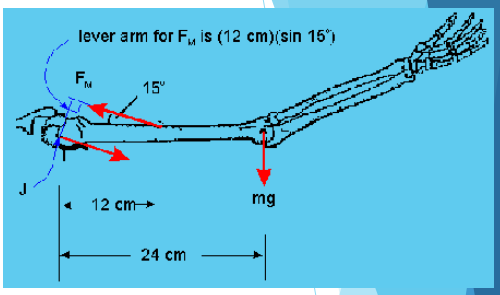
- If functional repetition is necessary for neurological advancement, how does one achieve this if they have inadequate strength for active movement against gravity?
- If the weight of the arm is too heavy, how do we expect them to use it?
- How do we get them strong enough?
- If we understand the muscles involved in healthy shoulder motion, how do we rebalance to healthy movement ratio in stroke survivors?

Shoulder Basics

- **Stability before mobility**
- Mobility- sacrifice stability
- Stability- accomplished by ligamentous attachments and complex array of muscular force couples.
- Physics: Rotation requires precise and coordinated force couples !!!



The lever length conundrum
Long = heavy

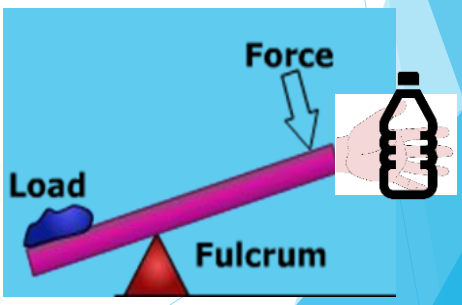


- Basic physics: Longer the lever = Heavier
  - What happens as the elbow reaches extension?

Moment of contemplation: What is the functional lever length for the LE with gait vs. the UE for reach?

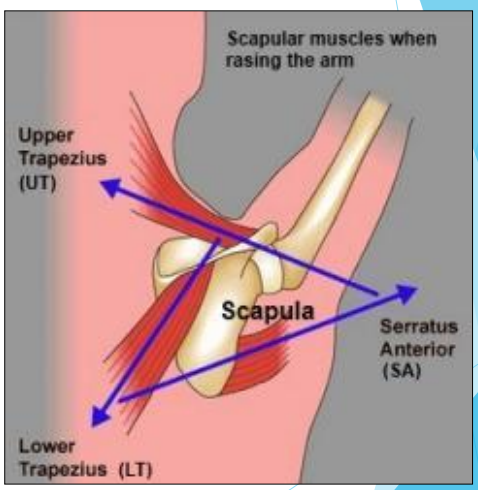
Force demand characteristics:

- Isometric → Eccentric→ Concentric



Shoulder Movement Fundamentals

- Primary movements of scapula
  - Upward rotation- 45-55 degrees
  - Posterior tilt- 20-40 degrees
  - ER- 15-35 degrees
    - Escamilla et al, 2009
  - Retraction- improves subacromial space
  - Protraction- decreases subacromial space
  - Anterior tilt, scapular IR- decreases
- Maintains the proper length tension relationship of RTC muscles to ER humerus



Scapula in motion

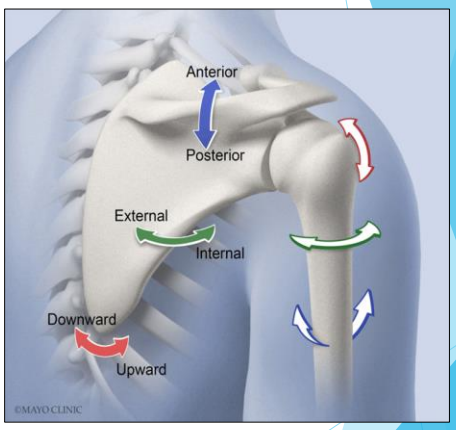
- http://www.youtube.com/watch?v=FHq3K6J3Wq8
- http://www.youtube.com/watch?v=Jmxz3bEjjGM

Video- Patient

- Doug Doffing Shirt
- ER Forward flexion posterior view
- M- Reaching posterior view

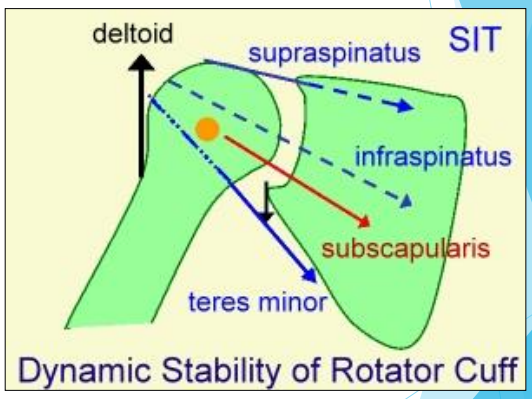
Scapulothoracic Joint

- Movements of the scapula
  - During shoulder movements: scapula demonstrates
    - Posterior or anterior tilting
    - Upward or downward rotation
    - Internal or external rotation
    - Superior or inferior translation
  - These movements occur in combination with each other during protraction and retraction movements.



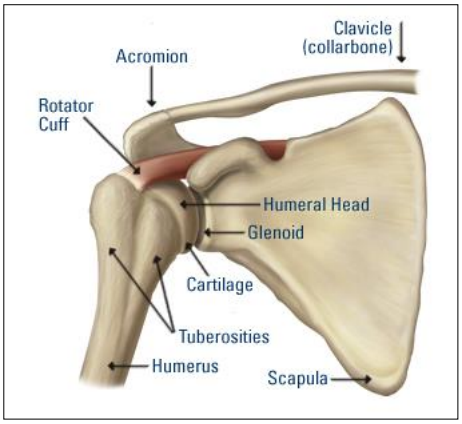
Shoulder Basics- cont.

- Force couples
  - Deltoid-
    - unopposed produces superior movement/translation of the humeral head
  - Rotator Cuff-
    - Controls humeral head compression
    - Collective downward force
      - In the plane of the scapula
      - How is this direction of force similar to the middle/lower trapezius?



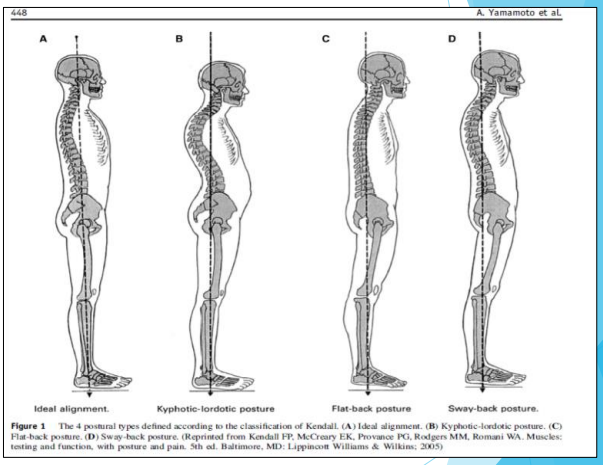
Impingement syndrome

- Greater and Lesser Tuberosity- must clear the Acromion and Coracoid (less common)
- Requires- humeral head depression + ER (humeral head) + proper scapulohumeral rhythm
- http://www.youtube.com/watch?v=TcsJOLSYcHg&feature=related

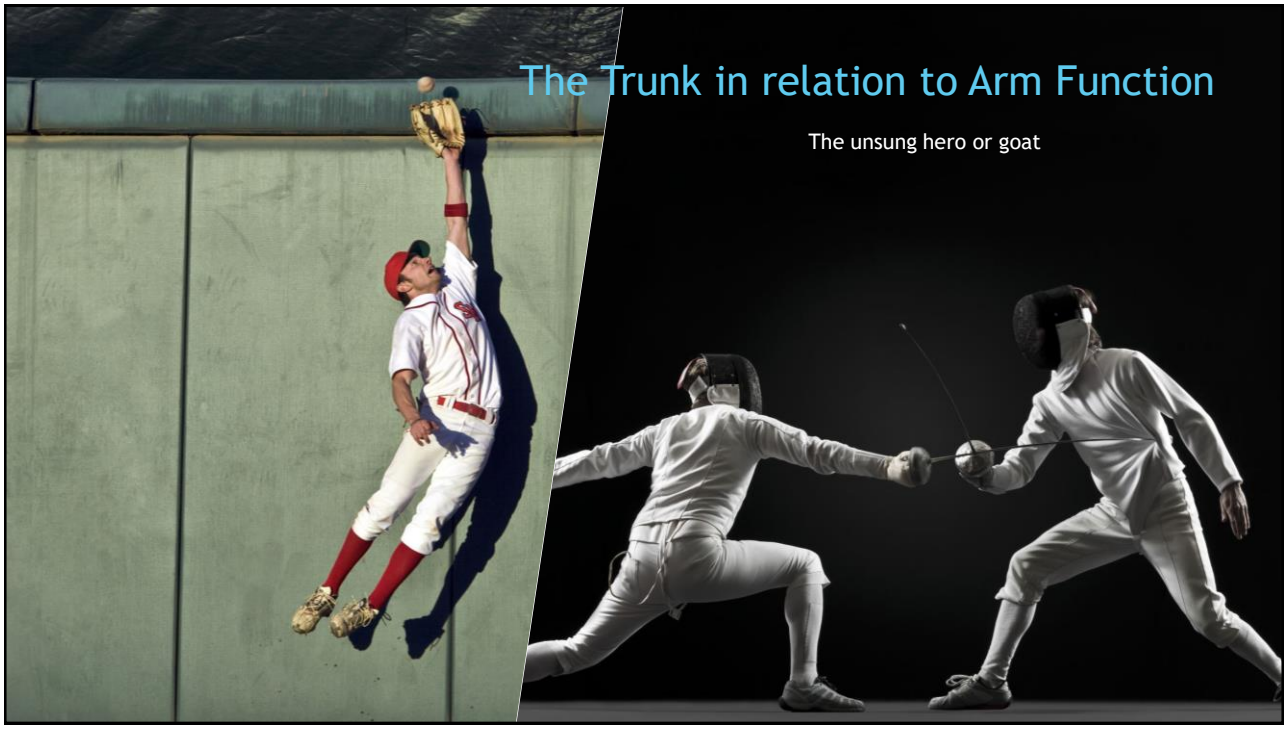


Effect of Posture on Healthy Shoulder Motion

- Where does the Scapula Go?
  - Photo A – scapula in "healthy starting alignment."
  - Photo B-
    - Excessive Scapular Elevation
    - Excessive Scapular Protraction
    - Excessive Anterior Tilt
    - ***Decreased subacromial space***
- Where does the humerus go?
  - Photo A- healthy starting alignment
  - Photo B-
    - Excessive Anterior Migration
    - Excessive IR



Dabholkar, Ajit, and Sujata Yardi. "Effects Of Scapular Muscle Strengthening On Shoulder Function And Disability In Shoulder Impingement Syndrome (SIS) -A Randomized Controlled Trial". *International Journal Of Therapies And Rehabilitation Research*, vol 4, no. 4, 2015, p. 26. *Scopemed Publishing*, doi:10.5455/ijtrr.00000062.

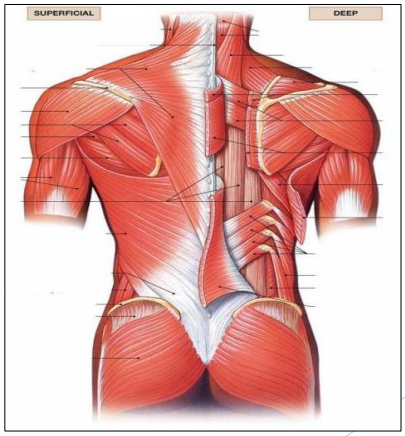


The Trunk in relation to Arm Function

- Any change in a body segment, changes the center of mass which requires a response of the trunk
- Anticipatory activation of the trunk musculature is required due to the downward and backward trunk displacement with upper extremity activation in open or closed chain tasks.
- Any activity that involves pushing, pulling, or lifting will initiate an immediate isometric contraction of the trunk flexors in order to stabilize the ribs, spine and pelvis
- Intermittent activity of the extensors is needed when the flexors contract to create a co-activated trunk and scapular stability required for limb function
- Trunk and BOS extend reach!

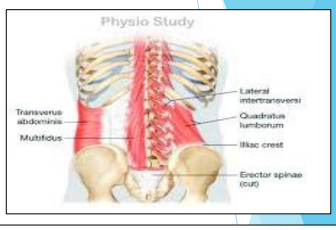
Muscular connection of the trunk and upper extremity

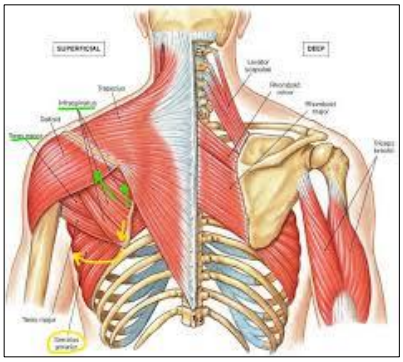
- Head and Cervical Spine
  - Sternocleidomastoid, Levator Scapulae, Scalenes
    - Contributes to orientation to space, balance, and goal oriented task in conjunction with the visual and vestibular system
- Ribs and Thoracic Spine
  - Serratus, Middle and Lower Trapezius, Rhomboids, Pectoralis Major and Minor
    - Contributes to balance and can increase/decrease reach
- Pelvis and Lumbar Spine
  - Trapezius through the attachment of the thoracolumbar fascia, Latissimus Dorsi
    - Connects upper trunk and lower extremities to serve as a BOS, contributes to balance and the length of reach

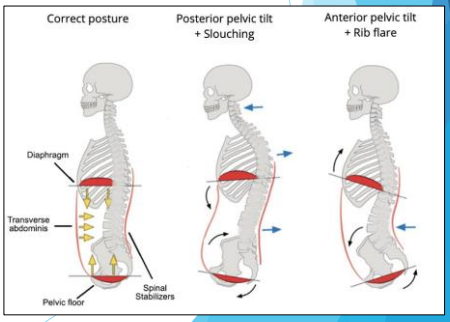


The Pelvis and Rib Cage- The Forgotten Foundation

- Pelvis and Ribs set the starting alignment from the bottom up.
- What happens to the scapula and humeral alignment as we deviate from healthy postures to unhealthy postures?







Assessing the Scapula

Dyskinesia- Scapulas gone wrong

“Why are scapulas and humeral heads so confusing?”

They are not happy, unless they are depressed.

“Why didn’t the shoulder have to take anti-depressants anymore?”

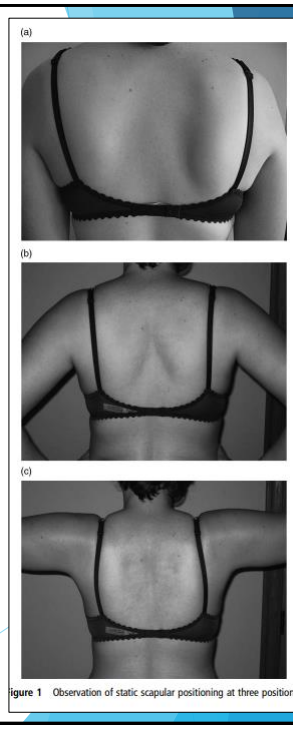
His/her/their OT utilized very complex assessment tools and treatment methods to restore healthy force couples again at the humeral head and scapula!!!!

Clinical Assessment of the Scapula

- Observational assessment vs. Specific Tests/objective measurements.
  - Observational: Quick and clinical friendly
  - Specific Tests:
    - Can provide objective data
    - Not time effective
- Observation: Static and Dynamic Scapular positioning.
  - 3 Positions of Scapular Rest:
    - Relaxed by side
    - Both hands on ipsilateral hips
    - 90 Shoulder ABD – if able
  - Abnormalities include:
    - Tilting, winging

Struyf et al, 2012

- Desired resting position in all 3 positions
  - Scapular spine: Nearly horizontal (+5 to -5 degrees up/down rotation)
  - ***Internally rotated*** ~ 40 degrees (in respect to frontal plane)
  - ***Anteriorly tilt*** ~ 10 degrees (fairly flat)
  - ***Medial Border***: ~parallel to the thoracic midline
  - ***Dominant side***: lower and further from spine
  - ***Superior Angle***: ~level with T3-4
  - ***Inferior Angle***: ~ level with T7-T9



igure 1 Observation of static scapular positioning at three positions.

Clinical Assessment of the Scapula

- SICK Scapular Syndrome: condition for overhead athletes with dyskinesis often demonstrate
  - Scapular Malposition
  - Inferior medial border prominence
  - Coracoid pain
  - Malposition Dyskinesis
- Observation of scapular motion
  - Scapular dyskinesis: Present or absent (yes or no).
  - Characterized as :
    - Winging or
    - Dysrhythmia-
      - Premature or excessive elevation or protraction
      - Non smooth or stuttering motion: during elevation or return from elevation
      - Rapid downward rotation during arm lowering

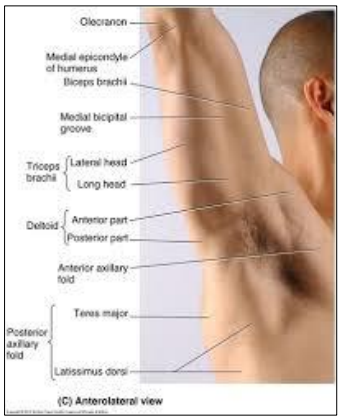
Struyf at al, 2012

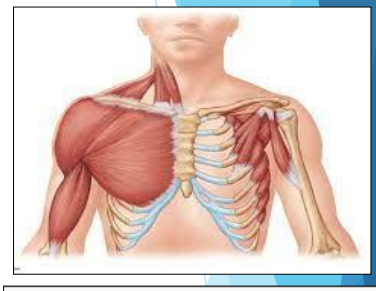
Kibler's Four Types of scapular dyskinesis

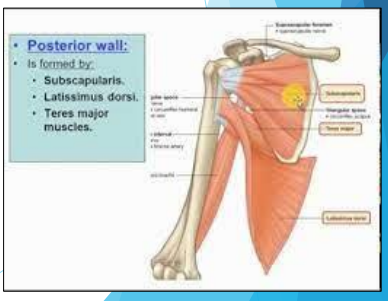
- Type 1: Inferior Angle Prominence
- Type 2: Medial Border Prominence
- Type 3: Excessive superior border elevation
- Type 4: Symmetrical and normal motion

Clinical Treatment of Scapular Dyskinesis

- Soft tissue elasticity- Does the patient have a range of issue?
  - Shortening of the following common muscles can highly contribute to scapular movement
    - Pec Minor: Anterior tipping
    - Pec Major
    - Latissimus Dorsi
    - Posterior / Inferior shoulder capsule: Look for ROM loss in capsular pattern
    - Levator scapulae
    - Subscapularis / Teres Major







Muscle performance in Scapular Dyskinesia

- Several authors have demonstrated altered muscle activity patterns in patients with shoulder impingement
  - Altered muscle strength or alterations in timing properties of
    - Decreased strength of Serratus Anterior
    - Hyperactivity and early activation of Upper Trapezius
    - Decreased Activity and late activation of Middle and Lower Trapezius.
  - "The scapula plays a very important role as a link between the trunk and the arm, transferring and increasing the energy, power and equilibrium from the lower extremities and the trunk into the arm." (Cools et al, 2013)
  - "Abnormal scapular position and kinematics might lead to a breakage of the functional kinetic chain, putting other links at risk for injury" (Cools et al, 2013)

Review > Br J Sports Med. 2014 Apr;48(8):692-7. doi: 10.1136/bjsports-2013-092148. Epub 2013 May 18.

Rehabilitation of scapular dyskinesis: from the office worker to the elite overhead athlete

Ann M J Cools [1], Filip Struyf, Kristof De Mey, Annelies Maenhout, Birgit Castelein, Barbara Cagnie

Affiliations + expand

PMID: 23687006 DOI: 10.1136/bjsports-2013-092148

Abstract

The scapula functions as a bridge between the shoulder complex and the cervical spine and plays a very important role in providing both mobility and stability of the neck/shoulder region. The association between abnormal scapular positions and motions and glenohumeral joint pathology has been well established in the literature, whereas studies investigating the relationship between neck pain and scapular dysfunction have only recently begun to emerge. Although several authors have emphasised the relevance of restoring normal scapular kinematics through exercise and manual therapy techniques, overall scapular rehabilitation guidelines decent for both patients with shoulder pain as well as patients with neck problems are lacking. The purpose of this paper is to provide a science-based clinical reasoning algorithm with practical guidelines for the rehabilitation of scapular dyskinesis in patients with chronic complaints in the upper quadrant.

Keywords: Exercise rehabilitation; Shoulder injuries; Sports rehabilitation programs.

The Relationship of Soft Tissue Length and Muscle Performance

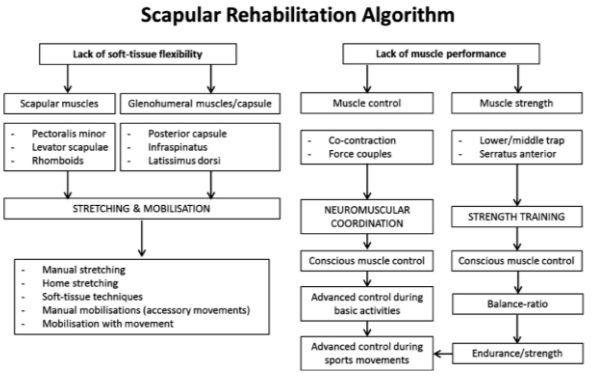


Figure 1 Scapular rehabilitation algorithm.

Cools AMJ, *et al. Br J Sports Med* 2014;**48**:692–697. doi:10.1136/bjsports-2013-092148

- Healthy Scapular Movement is affected by:
  - Soft tissue flexibility (or lack thereof)
  - Muscle Control
  - Muscle strength
- Appropriate treatments for scapular dyskinesis needs to involve all potential causes.

Benefits of Closed Chain Strengthening

- Push up Variations- "Push up plus"
  - Challenge SA activation
  - Need to be selected with caution – with impingement related pain
    - Lunden et al. state that this may put the GH joint in a position that decreases available subacromial joint space.
- Wall slide-
  - Hardwick et al.- produces similar SA activity to other closed chain exercises but safer.
  - Uhl et al-
    - supporting the arm during wall slide and bench activities improves SA and LT activity.
    - Low activity in UT and GH muscles.

Muscle Strength and Muscle Imbalance Deficit

- " Selective activation of the weaker muscles in parts with minimal activity of the hyperactive muscles is an important component to the second stage of scapular muscle rehabilitation"
- "A continuum of functional exercises may be suggested with increasing activity of the LT."
  - Suggested sequence-
    - Isometric low row → Prone extension at 0 → Sidelying ER → Prone horizontal abduction with ER.
- Push up plus- Popular for training of SA- However has a high muscle strength demand
  - Elbow push up
  - Dynamic hug
  - Supine punch
  - Wall sliding exercises
- Intramuscular trapezius training- 4 Recommended Exercises
  - Optimal UT/MT and UT/LT ratio and guarantee early activation of the LT and inhibition latency of the UT
  - Sidelying ER
  - Sidelying FF
  - Prone horizontal ABD with ER
  - Prone extension

Stance variations and affect on Scapular Performance

- Integration of BOS changes to increase selective muscle activity
  - Push up plus -
    - Ipsilateral leg is extended = increased SA activity
    - Contralateral leg extended = Increased LT activation
  - Open chain Rowing
    - Unilateral stance -
      - Increases scapular muscle activity
      - Improves the UT/LT ratio
      - Diagonal patterns including the Lower Limb and core muscle activity are in favor of scapular muscle activity- especially lower trap!

frontiers in
HUMAN NEUROSCIENCE

ORIGINAL RESEARCH ARTICLE
published: 17 November 2014
doi: 10.3389/fnhum.2014.00933

Characteristics of neuromuscular control of the scapula after stroke: a first exploration

Liesbet De Baets[1]*, Ellen Jaspers[2], Luc Janssens[3] and Sara Van Deun[1]

[1] *REVAL Rehabilitation Research Center – BIOMED Biomedical Research Institute, Faculty of Medicine and Life Sciences, Hasselt University, Diepenbeek, Belgium*
[2] *Neural Control of Movement Laboratory, ETH Zurich, Zurich, Switzerland*
[3] *Faculty of Industrial Engineering Sciences, KU Leuven, Leuven, Belgium*

- ***Study Goal:*** characterize scapular muscle timing in stroke patients with and without shoulder pain.
- Muscle activity of upper trapezius, lower trapezius, serratus anterior, infraspinatus, and anterior deltoid (AD) was measured (DelsysTrigno surface EMG system)
  - 14 Healthy controls vs. 30 stroke patients. (10 with hemiplegic shoulder pain).
- Participants performed:
  - 45 degrees of FF (anteflexion) and full anteflexion:
  - 2 load conditions for each height

frontiers in
HUMAN NEUROSCIENCE

ORIGINAL RESEARCH ARTICLE
published: 17 November 2014
doi: 10.3389/fnhum.2014.00933

Characteristics of neuromuscular control of the scapula after stroke: a first exploration

Liesbet De Baets[1]*, Ellen Jaspers[2], Luc Janssens[3] and Sara Van Deun[1]

[1] REVAL Rehabilitation Research Center – BIOMED Biomedical Research Institute, Faculty of Medicine and Life Sciences, Hasselt University, Diepenbeek, Belgium
[2] Neural Control of Movement Laboratory, ETH Zurich, Zurich, Switzerland
[3] Faculty of Industrial Engineering Sciences, KU Leuven, Leuven, Belgium

- Across all load conditions and groups:
  - In Stroke patients without pain:
    - ***Lower trapezius*** had an earlier activation vs. patients with pain.
    - ***Serratus anterio***r showed a delayed onset.
- For full range tasks:
  - Participants without shoulder pain: Used early and prolonged activity of the ***infraspinatus***.

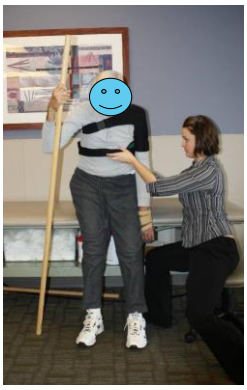
Postural Consequences of the "Heavy Arm"

Static Visual Assessment

Analyzing- Sitting from front

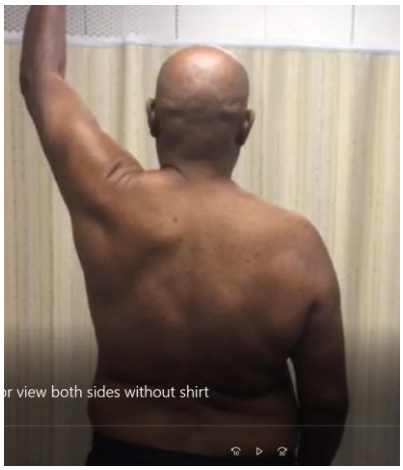
Sitting from the side

Standing from front



Standing from the side

Observation- Postural analysis



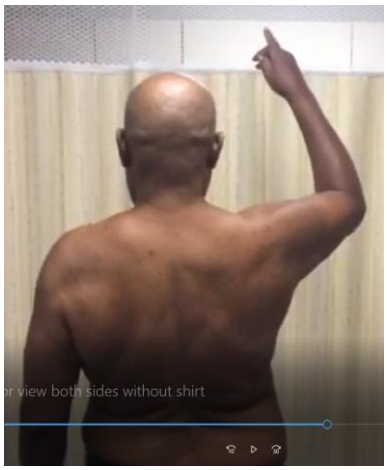


TABLE 2 Summary of Scapular Kinematics During Arm Elevation in Healthy and Pathologic States

Group	Healthy	Impingement or Rotator Cuff Disease	Glenohumeral Joint Instability	Adhesive Capsulitis
Primary scapular motion	Upward rotation	Lesser upward rotation	Lesser upward rotation	Greater upward rotation
Secondary scapular motion	Posterior tilting	Lesser posterior tilting	No consistent evidence for alteration	No consistent evidence for alteration
Accessory scapular motion	Variable internal/external rotation	Greater internal rotation	Greater internal rotation	No consistent evidence for alteration
Presumed implications	Maximize shoulder range of motion and available subacromial space	Presumed contributory to subacromial or internal impingement	Presumed contributory to lesser inferior and anterior joint stability	Presumed compensatory to minimize functional shoulder range-of-motion loss

TABLE 3 Proposed Biomechanical Mechanisms of Scapular Kinematic Deviations

Mechanism	Associated Effects
Inadequate serratus activation	Lesser scapular upward rotation and posterior tilt
Excess upper trapezius activation	Greater clavicular elevation
Pectoralis minor tightness	Greater scapular internal rotation and anterior tilt
Posterior glenohumeral joint soft tissue tightness	Greater scapular anterior tilt
Thoracic kyphosis or flexed posture	Greater scapular internal rotation and anterior tilt, lesser scapular upward rotation

TABLE 3 Proposed Biomechanical Mechanisms of Scapular Kinematic Deviations

Mechanism	Associated Effects
Inadequate serratus activation	Lesser scapular upward rotation and posterior tilt
Excess upper trapezius activation	Greater clavicular elevation
Pectoralis minor tightness	Greater scapular internal rotation and anterior tilt
Posterior glenohumeral joint soft tissue tightness	Greater scapular anterior tilt
Thoracic kyphosis or flexed posture	Greater scapular internal rotation and anterior tilt, lesser scapular upward rotation

Ludewig & Reynolds, 2009

Subacromial Impingement Syndrome: Musculoskeletal Causes

- Weakness of Serratus anterior, Middle and Lower trapezius
- Overactivity of the Upper Trapezius
- Weakness or damage to the rotator cuff muscles
- Tightness of posterior GH capsule or posterior rotator cuff muscles
- Tightness of Pectoralis minor or short head of the biceps
- Excessive thoracic kyphosis

Neumann. Kinesiology of the Musculoskeletal System, 3rd ed.

Subacromial Impingement Syndrome: Abnormal Kinematic Causes

- Limited Up Rotation, Posterior Tilt and Add of scapula
- Excessive Anterior Tilt and Abd of scapula
- Limited Upward/posterior rotation of clavicle
- Excessive superior movement of humerus during Abduction and flexion
- Limited GH ER during Abduction and flexion

Neumann. Kinesiology of the Musculoskeletal System, 3rd ed.

Scapula- Building the foundation for stability- moving to mobility.

Review > Br J Sports Med. 2014 Apr;48(8):692-7. doi: 10.1136/bjsports-2013-092148. Epub 2013 May 18.

Rehabilitation of scapular dyskinesis: from the office worker to the elite overhead athlete

Ann M J Cools[1], Filip Struyf, Kristof De Mey, Annelies Maenhout, Birgit Castelein, Barbara Cagnie

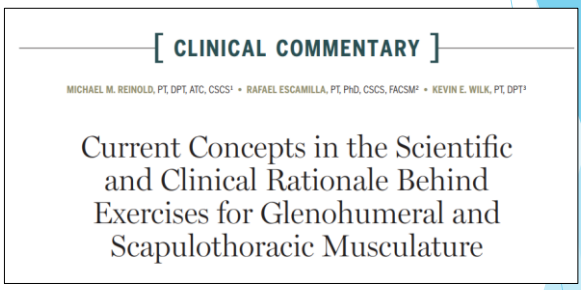
Affiliations + expand

PMID: 23687006 DOI: 10.1136/bjsports-2013-092148

Abstract

The scapula functions as a bridge between the shoulder complex and the cervical spine and plays a very important role in providing both mobility and stability of the neck/shoulder region. The association between abnormal scapular positions and motions and glenohumeral joint pathology has been well established in the literature, whereas studies investigating the relationship between neck pain and scapular dysfunction have only recently begun to emerge. Although several authors have emphasised the relevance of restoring normal scapular kinematics through exercise and manual therapy techniques, overall scapular rehabilitation guidelines decent for both patients with shoulder pain as well as patients with neck problems are lacking. The purpose of this paper is to provide a science-based clinical reasoning algorithm with practical guidelines for the rehabilitation of scapular dyskinesis in patients with chronic complaints in the upper quadrant.

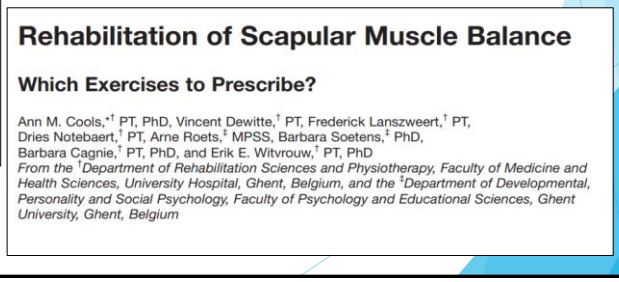
Keywords: Exercise rehabilitation; Shoulder injuries; Sports rehabilitation programs.



[CLINICAL COMMENTARY]

MICHAEL M. REINOLD, PT, DPT, ATC, CSCS[1] • RAFAEL ESCAMILLA, PT, PhD, CSCS, FACSM[2] • KEVIN E. WILK, PT, DPT[3]

Current Concepts in the Scientific and Clinical Rationale Behind Exercises for Glenohumeral and Scapulothoracic Musculature



Rehabilitation of Scapular Muscle Balance

Which Exercises to Prescribe?

Ann M. Cools,*† PT, PhD, Vincent Dewitte,† PT, Frederick Lanszweert,† PT, Dries Notebaert,† PT, Arne Roets,‡ MPSS, Barbara Soetens,‡ PhD, Barbara Cagnie,† PT, PhD, and Erik E. Witvrouw,† PT, PhD

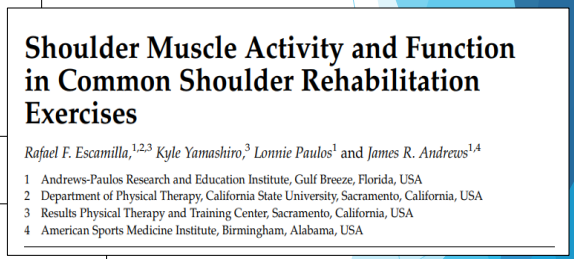
From the †Department of Rehabilitation Sciences and Physiotherapy, Faculty of Medicine and Health Sciences, University Hospital, Ghent, Belgium, and the ‡Department of Developmental, Personality and Social Psychology, Faculty of Psychology and Educational Sciences, Ghent University, Ghent, Belgium

Scapula- Stability to Mobility

[CLINICAL COMMENTARY]

PAULA M. LUDEWIG, PT, PhD[1] • JONATHAN F. REYNOLDS, PT, PhD[2]

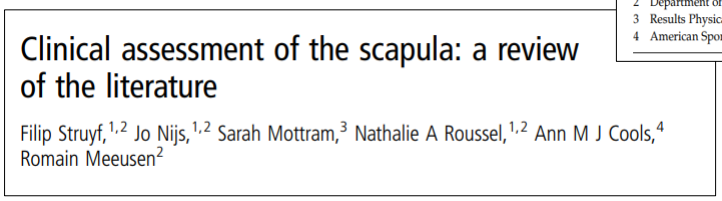
The Association of Scapular Kinematics and Glenohumeral Joint Pathologies



Shoulder Muscle Activity and Function in Common Shoulder Rehabilitation Exercises

Rafael F. Escamilla,[1,2,3] Kyle Yamashiro,[3] Lonnie Paulos[1] and *James R. Andrews[1,4]*

1 Andrews-Paulos Research and Education Institute, Gulf Breeze, Florida, USA
2 Department of Physical Therapy, California State University, Sacramento, California, USA
3 Results Physical Therapy and Training Center, Sacramento, California, USA
4 American Sports Medicine Institute, Birmingham, Alabama, USA



Clinical assessment of the scapula: a review of the literature

Filip Struyf,[1,2] Jo Nijs,[1,2] Sarah Mottram,[3] Nathalie A Roussel,[1,2] Ann M J Cools,[4] Romain Meeusen[2]

References

Betti, S., Zani, G., Guerra, S., Castiello, U., & Sartori, L. (2018). Reach-to-grasp movements: A multimodal techniques study. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.00990

De Baets, L., Jaspers, E., Janssens, L., & Van Deun, S. (2014). Characteristics of neuromuscular control of the scapula after stroke: A first exploration. *Frontiers in Human Neuroscience*, *8*. https://doi.org/10.3389/fnhum.2014.00933

De Baets, L., Van Deun, S., Monari, D., & Jaspers, E. (2016). Three-dimensional kinematics of the scapula and trunk, and associated scapular muscle timing in individuals with stroke. *Human Movement Science*, *48*, 82–90. https://doi.org/10.1016/j.humov.2016.04.009

Dell'Uomo, D., Morone, G., Centrella, A., Paolucci, S., Caltagirone, C., Grasso, M. G., Traballesi, M., & Iosa, M. (2017). Effects of scapulohumeral rehabilitation protocol on trunk control recovery in patients with Subacute Stroke: A pilot randomized controlled trial. *NeuroRehabilitation*, *40*(3), 337–343. https://doi.org/10.3233/nre-161421

Shumway-Cook. (2016). Normal reach, grasp, & Manipulation. In Motor control (5th ed., pp. 465-489). Wolters Kluwer Law & Business.

Yang, S.-H., Chung, E.-J., Lee, J., Lee, S.-H., & Lee, B.-H. (2021). The effect of trunk stability training based on visual feedback on trunk stability, balance, and upper limb function in stroke patients: A randomized control trial. *Healthcare*, *9*(5), 532. https://doi.org/10.3390/healthcare9050532