

On-field demonstration:

On-field motion analysis for overhead sports

現場示範：過肩投擲運動的實地動作分析

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Croucher Sports Biomechanics Course 2026

Step	Backswing
S1 <i>No Step</i> —The child throws from the initial stationary foot position.	B1 <i>No Backswing</i> —The ball in the hand moves directly forward to release from the arm's original position.
S2 <i>Homolateral Step</i> —The child steps with the foot on the same side as the throwing hand.	B2 <i>Elbow and Humeral Flexion</i> —The ball moves away from the intended line of flight to a position behind or alongside the head.
S3 <i>Contralateral, Short Step</i> —The child steps with the foot on the opposite side from the throwing hand.	B3 <i>Circular Upward Backswing</i> —The ball moves away from the intended line of flight to a position behind the head via a circular overhead movement.
S4 <i>Contralateral, Long Step</i> —The child steps with the opposite foot a distance of over half the child's standing height.	B4 <i>Circular, Downward Backswing</i> —The ball moves away from the intended line of flight to a position behind the head via a circular, down-and-back motion, which carries the hand below the waist.
Trunk	
T1 <i>No Trunk Action or Forward-Backward Movements</i> —Only the arm is active in force production. If trunk action occurs, it accompanies the forward thrust of the arm by flexing forward at the hips. Sometimes there is trunk extension prior to hip flexion.	
T2 <i>Upper Trunk Rotation or Total "Block" Rotation</i> —The spine and pelvis both rotate away from the intended line of flight and then simultaneously begin forward rotation, acting as a unit or "block."	
T3 <i>Differentiated Rotation</i> —The pelvis precedes the upper spine in initiating forward rotation. The thrower twists away from the intended line of ball flight and then begins forward rotation with the pelvis while the upper spine is twisting away.	
Humerus	Forearm
H1 <i>Humerus Oblique</i> —The humerus moves forward to ball release.	F1 <i>No Forearm Lag</i> —The forearm and ball move steadily forward to ball release.
H2 <i>Humerus Aligned But Independent</i> —The humerus moves forward to ball release in a plane horizontally aligned with the shoulder, forming a right angle between humerus and trunk.	F2 <i>Forearm Lag</i> —The forearm and ball appear to "lag" behind the shoulder.
H3 <i>Humerus Lags</i> —The humerus moves forward to ball release horizontally aligned, but at the moment the shoulders (upper spine) reach front facing, the humerus remains within the outline of the body (as seen from the side).	F3 <i>Delayed Forearm Lag</i> —The lagging forearm delays reaching its final point of lag until the moment of front facing.

Roberton 1997, Gallahue 2012



Skill criteria (Department of Education Western Australia, 2013b)

1	Stands side on to direction of throw
2	Throwing arm moves in a downward and backward arc
3	Opposite foot to throwing arm steps forward
4	Hips then shoulders rotate forward
5	Elbow bends as throwing arm moves behind head
6	Forearm and hand lag behind upper arm
7	Throwing arm follows through across body

Fundamental Motor Skill	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
	<i>Initial Stage</i>		<i>Emerging Stages</i>		<i>Proficient Stage</i>
Throw	<i>Chop</i> Vertical windup “Chop” throw Feet stationary No spinal rotation	<i>Sling Shot</i> Horizontal wind-up “Sling shot throw” Block rotation Follow-through across body	<i>Ipsilateral Step</i> High windup Ipsilateral step Little spinal rotation Follow-through across body	<i>Contralateral Step</i> High windup Contralateral step Little spinal rotation Follow-through across body	Windup Downward arc windup Contralateral step Segmented body rotation Arm-leg follow-through

Gallahue 2012

Lack of capability or physical limitation?

Screening → On-field testing
→ Neuromuscular testing

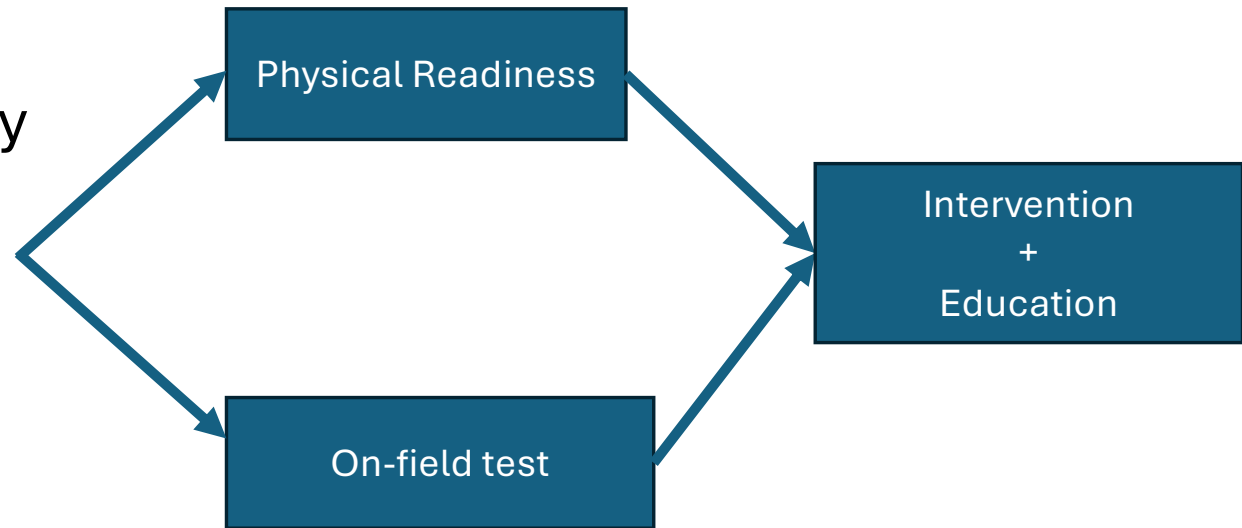
Screening



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<https://www.topvelocity.net/2023/08/09/most-important-muscles-used-in-throwing-a-baseball/>

Part 1: Setting Up Your Body
Part 2: The Throwing Arm
Part 3: The Helper arm
Part 4: The Finish



On-field testing



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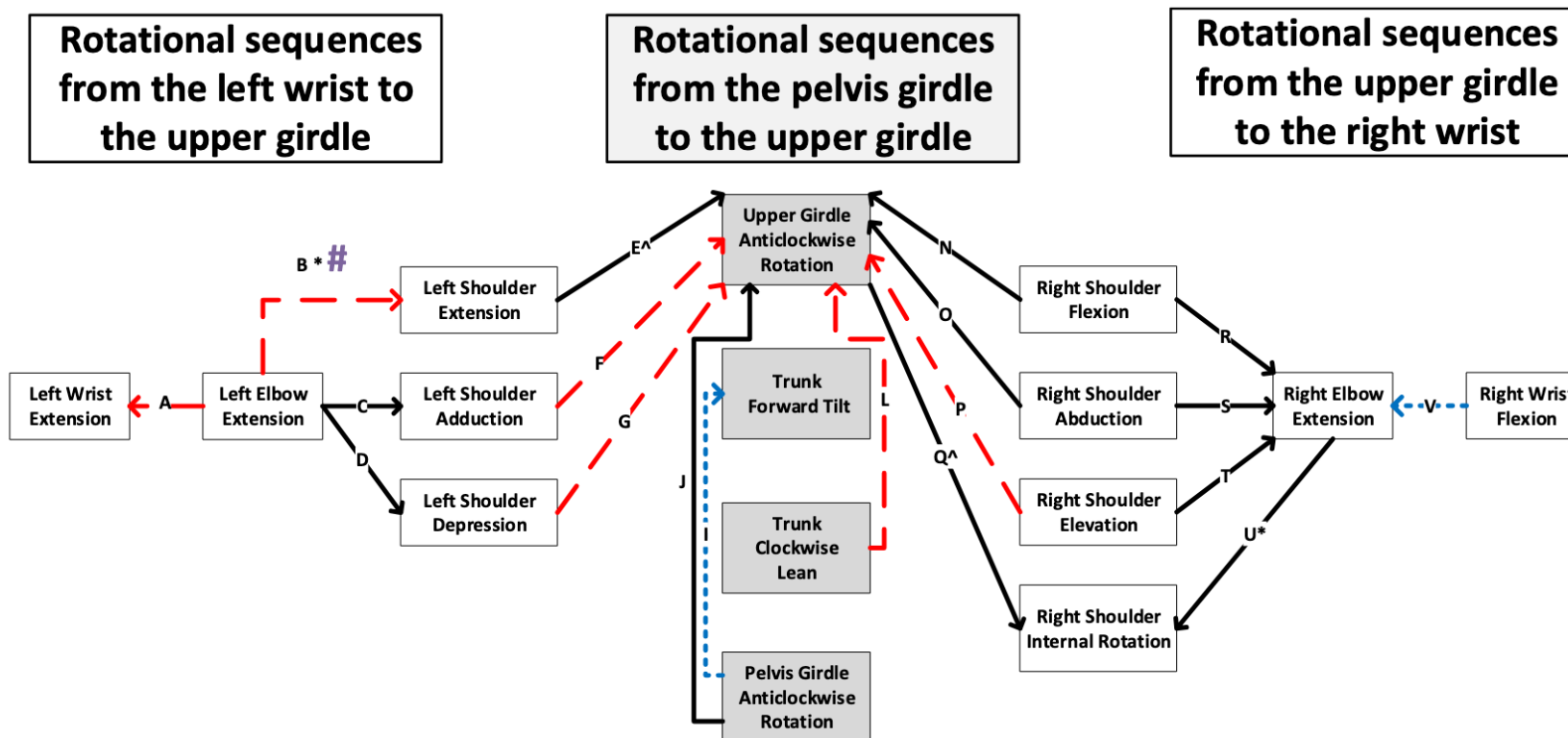
<https://www.topvelocity.net/2023/08/09/most-important-muscles-used-in-throwing-a-baseball/>

Neuromuscular Strategy



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<https://www.topvelocity.net/2023/08/09/most-important-muscles-used-in-throwing-a-baseball/>

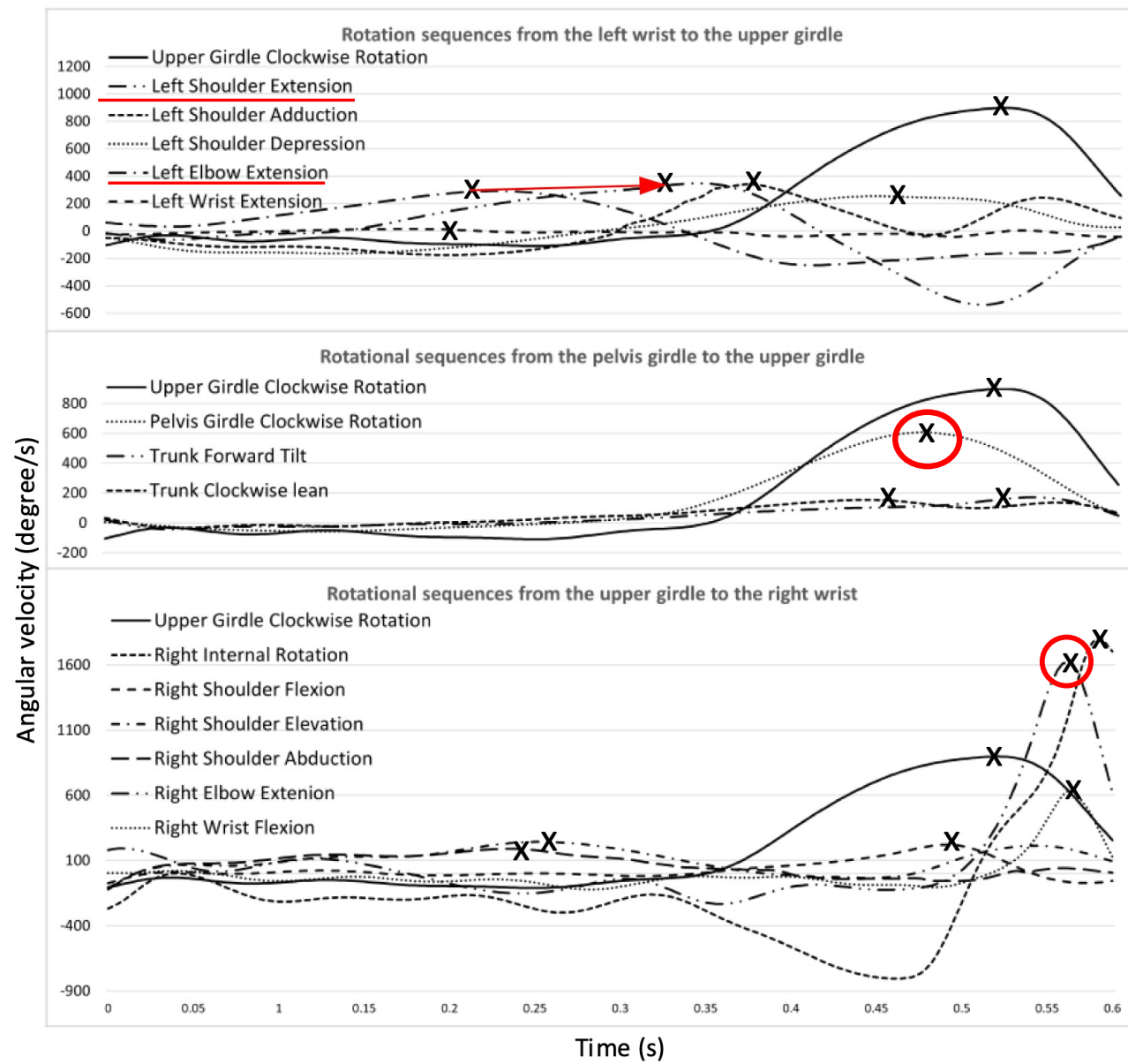


From to: Significant within-group differences in times of two successive events in both groups
 From to: Significant within-group differences in times of two successive events in the Skilled Group only
 From to: Significant within-group differences in times of two successive events in the Less Skilled Group only

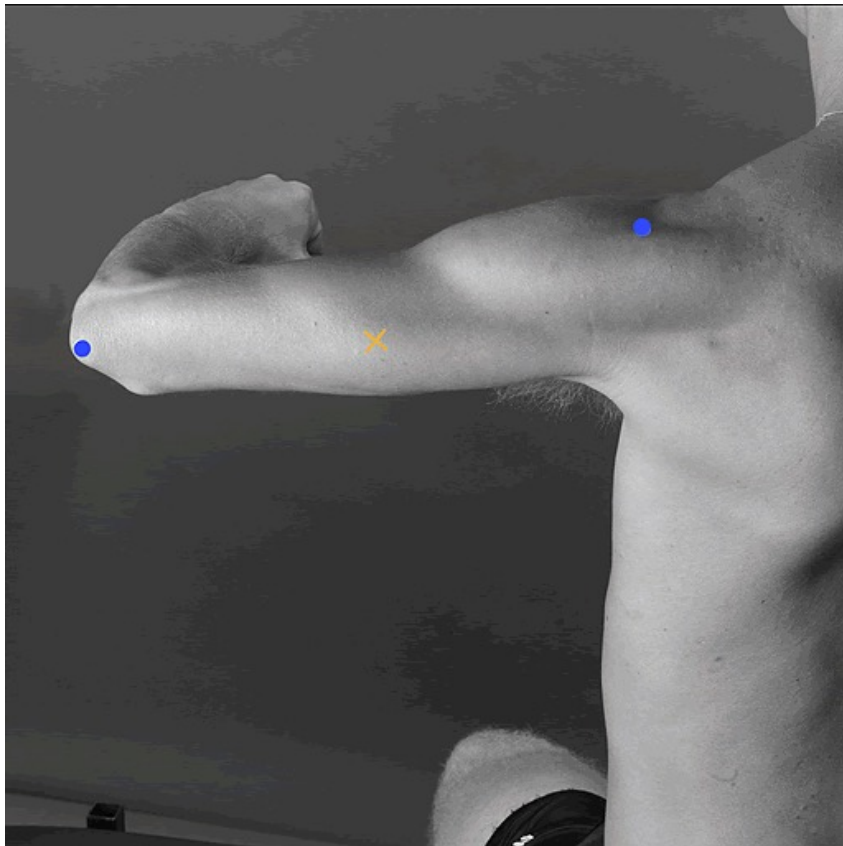
* The Skilled Group had significantly greater between-group differences in temporal spacing between events than the Less Skilled Group

^ The Less Skilled Group had significantly greater between-group differences in temporal spacing between events than the Skilled Group

Critical segmental sequencing feature (i.e. segmental sequence with significant within-group differences in times of two successive events and between-group differences in temporal spacing between events)

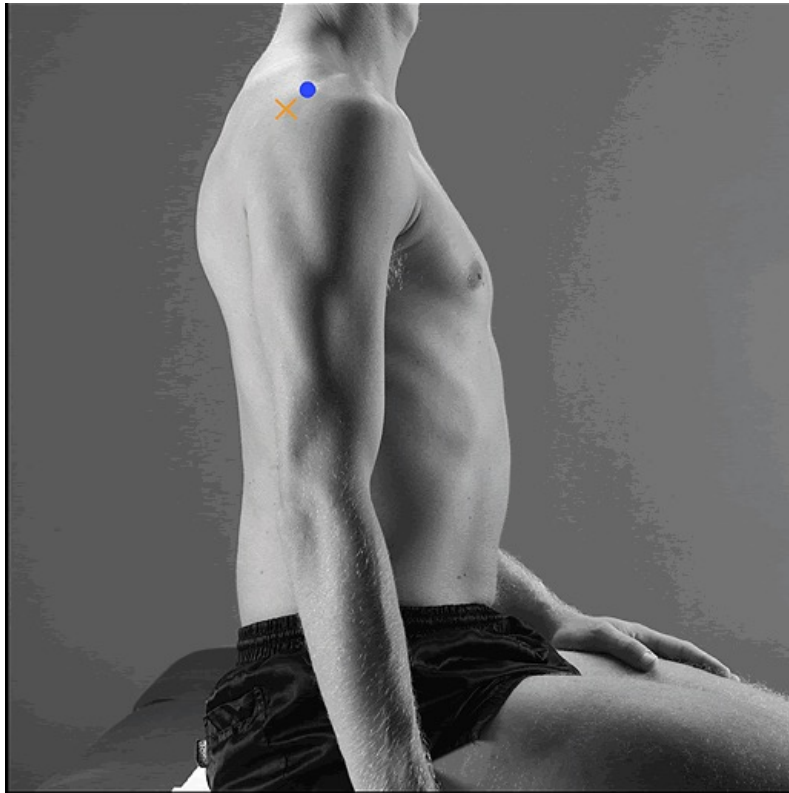


Triceps Brachii - Long Head



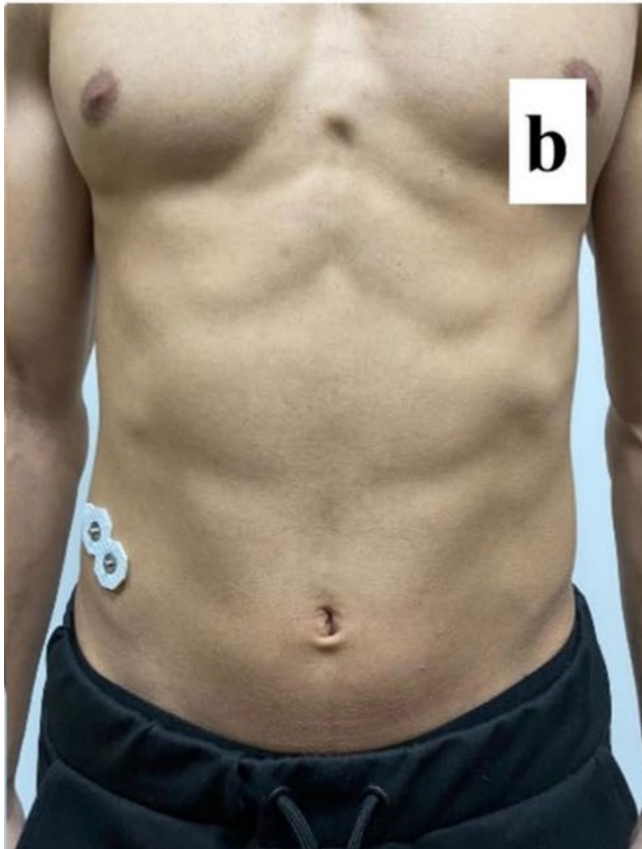
Starting posture	Sitting with the shoulder at approximately 90 degrees abduction with the arm 90 degrees flexed and the palm of the hand pointing downwards.
Electrode size	Maximum size in the direction of the muscle fibres: 10 mm.
Electrode distance	20 mm
Electrode placement	
- location	A 50 % on the line between the posterior crista of the acromion and the olecranon at 2 finger widths medial to the line.
- orientation	In the direction of the line between the posterior crista of the acromion and the olecranon.

Posterior Deltoid (left)



Starting posture	Erect sitting with the arms hanging vertically and the palm of the hand pointing inwards.
Electrode size	Maximum size in the direction of the muscle fibers: 10 mm.
Electrode distance	20 mm
Electrode placement	
- location	Center the electrodes in the area about two fingerbreaths behind the angle of the acromion.
- orientation	In the direction of the line between the acromion and the little finger.

External Oblique (Right)



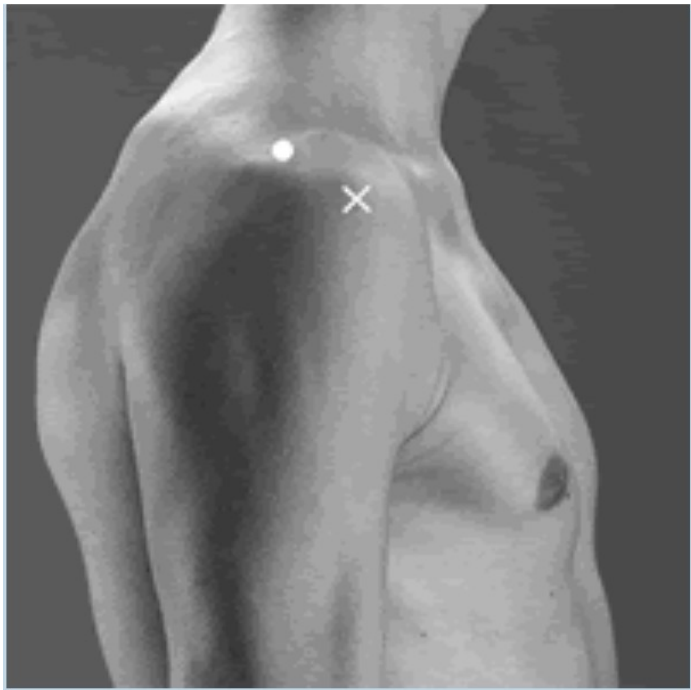
Placement

- 1 cm below and 14 cm lateral to the umbilicus at a 45° angle to the area between the lowest level of the rib and the pubic bone

Participant Position

- Standing.

Anterior Deltoid (Right)



Starting posture	Sitting with the arms hanging vertically and the palm pointing inwards.
Electrode size	Maximum size in the direction of the muscle fibers: 10 mm.
Electrode distance	20 mm
Electrode placement	
- location	one finger width distal and anterior to the acromion.
- orientation	In the direction of the line between the acromion and the thumb.

<https://www.seniam.org>

Expected sequence?!?

1) Long head of Triceps (non-throwing) → Posterior Deltoid (non-throwing)
→ External Oblique (right)
→ Anterior Deltoid (throwing) → Long head of Triceps (Throwing)

2) BUT..... No one single representation of muscle/ muscle group
upper girdle rotation and trunk motions are segmental movements, not individual muscle actions

3) AND
Muscle activation comes before joint ROM

Key references

Cinarli, F. S., & Kafkas, M. E. (2025). Neuromuscular activation following anti-movement and dynamic core training: A randomized controlled comparative study. *European Journal of Applied Physiology*, 125(9), 2449–2459. <https://doi.org/10.1007/s00421-025-05768-4>

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