



CHIN-UP & PULL-UP

MECHANICAL
DECISION SCIENCE
GLOBAL REFERENCE



MUSCLE
MECHANICS



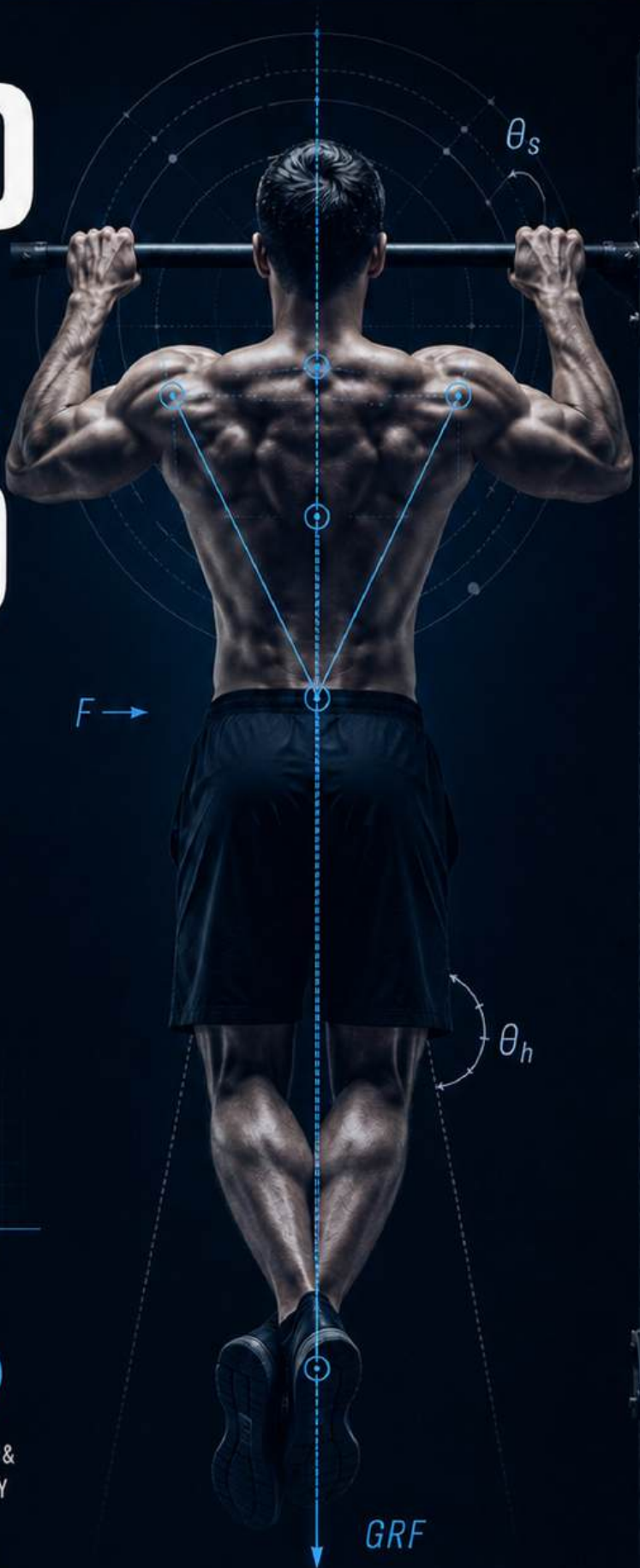
JOINT
KINEMATICS



CONTROL &
STRATEGY

DR NEERAJ MEHTA, PHD

MMSx AUTHORITY INSTITUTE FOR
MOVEMENT MECHANICS & BIOMECHANICS RESEARCH



The Chin-Up and Pull-Up

A COMPLETE MECHANICAL DECISION SCIENCE

MMSX AUTHORITY INSTITUTE · GLOBAL REFERENCE
EDITION

The Chin-Up and Pull-Up

*A Complete Mechanical Decision Science —
from the First Hang to Advanced Weighted Pulling*

GLOBAL REFERENCE EDITION · FULL BOOK

Dr Neeraj Mehta, PhD

Clinical Biomechanics Scientist · Founder & Principal Investigator
Editor-in-Chief, Journal of Movement Mechanics & Biomechanics Science

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EDUCATIONAL-USE DISCLAIMER

This reference is educational. It does not constitute medical diagnosis, an emergency-care protocol, or a replacement for individual clinical assessment. Chest pain, neurological signs, acute trauma, progressive weakness, suspected tendon rupture, unexplained symptoms and post-surgical restrictions require evaluation by a qualified professional. Movement decisions involve individual risk; the reader is responsible for assessing fitness for activity and seeking professional guidance where appropriate.

ABOUT THE EDITOR-IN-CHIEF

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His applied and clinical work is registered on ClinicalTrials.gov across the MOVE™ Protocol and the BPIT™ programme, and his research output is indexed through ORCID, Google Scholar and ResearchGate. Alongside his scientific work he has a long competitive background in strength and combat sports, which informs the practical, load-management emphasis of this reference.

Core intellectual position

The through-line of Dr Mehta's work — and the organising premise of this book — is that biomechanics is a **mechanical decision science**: a discipline of force vectors, torque, moment arms, ground-reaction forces, elastic energy and tissue-tolerance thresholds, rather than descriptive anatomy. The chin-up and pull-up are treated throughout as a load-transfer decision to be reasoned about, not a posture to be copied.

ABOUT THE INSTITUTE

MMSx Authority Institute

The MMSx Authority Institute for Movement Mechanics & Biomechanics Research, Inc. is a non-profit research institute dedicated to advancing movement as a measurable, decision-driven science. Its work connects laboratory biomechanics, clinical reasoning and applied coaching, and is disseminated through the Institute's open-access reference series and the Journal of Movement Mechanics & Biomechanics Science.

This reference draws on the Institute's registered studies and its DOI-registered decision frameworks, which supply the vocabulary and the load-management logic used across the ten parts that follow.

Table 0.A. Registered studies referenced by this reference

Study	Registration	Scope
MOVE™ Protocol	NCT07220200	Movement-optimisation protocol (n = 40)
BPIT™ Pilot	NCT07296640	Back-pain intervention pilot (n = 23)
BPIT™ Multi-Cohort	NCT07256717	Multi-cohort extension (n = 369)

Table 0.B. DOI-registered decision frameworks

Framework	Persistent identifier	Role in this book
MMSx-SCAN™ v2.1	10.17605/OSF.IO/F87N2	Screening and decision scaffold for vertical pulling
NEEBAL™ Principle	10.5281/zenodo.17664904	Load-tolerance reasoning
BPIT™ 5-Line Principle	10.5281/zenodo.17594977	Trunk and spine load management
MOVE™ Protocol	NCT07220200	Progression and re-test logic

EDITORIAL PURPOSE

What this book is, and is not

This Global Reference Edition is a complete, end-to-end educational text for the chin-up and pull-up. It integrates biomechanics, movement decision science, coaching progression, tissue-tolerance reasoning and applied programming — from the first hang to advanced weighted pulling. Every chapter follows the same structure: a plain-language explanation, the mechanical decision science, the coaching and clinical application, a credibility caution, tables and quick cards, and an integrated real-human figure.

Credibility charter

This book does not claim that one pull-up technique is universally safest or strongest. It claims only what mechanics, coaching evidence and clinical reasoning can support: grip, range, assistance, tempo, fatigue, anthropometry and symptoms change the problem being solved.

The goal is not to make every athlete perform the same repetition. It is to preserve a clear mechanical problem, choose an entry point that matches capacity, and progress exposure only when the athlete can keep position, control and recovery stable.

Research is used as a compass, not a script. Studies inform grip, activation, scapular motion and progression; the individual athlete's response still governs the final decision.

SAFETY SCOPE

When to stop and refer

The reasoning in this reference is designed to keep training decisions inside a defensible envelope. It does not replace individual clinical assessment, and it is not a substitute for professional evaluation of pain or injury.

Seek qualified evaluation before loading if any of the following are present

Chest pain or breathlessness · neurological signs (numbness, pins-and-needles, weakness, loss of coordination) · acute trauma or a fall onto the arm or shoulder · progressive or unexplained weakness · sudden loss of strength with a painful "give-way" (possible tendon rupture) · night pain or constant unremitting pain · recent surgery or a standing post-surgical restriction · any symptom the athlete or coach cannot confidently explain.

Where these are absent, the traffic-light and tissue-tolerance logic used throughout the book provides a structured way to load, monitor and progress. Where they are present, the correct first decision is referral, not regression.

HOW TO USE THIS BOOK

Five reader lenses

The book is written to be read from more than one direction. Each lens below points to the parts that will repay attention first; every reader benefits from Part I, which fixes the shared vocabulary and the decision model used everywhere else.

Table 0.2. Reader lenses

Lens	Reader	Primary use	Start with
Beginner	General trainee	Learn the movement and progress safely.	Parts I, V, VI
Coach	Strength coach / personal trainer	Diagnose faults, choose progressions, coach clearly.	Parts I, VII, IX
Clinician	Rehabilitation professional	Match load to symptoms and capacity.	Parts III, VIII, VII
Strength athlete	Calisthenics, climbing, tactical, strength	Build strict, high-volume or weighted performance.	Parts V, VI, IX
Researcher / educator	Biomechanics / movement-science reader	Use precise vocabulary and the evidence map.	Parts II, III, IV, X

How each chapter is built: plain-language explanation → key idea → mechanical decision map → evidence note → progression view → credibility caution → field protocol → integrated figure → field checklist → coaching translation. The structure is constant so that the reasoning, not the layout, carries the learning.

MASTER CONTENTS

The ten-part architecture

The reference is organised as one hundred and twenty chapters across ten parts. The sequence moves from foundations and vocabulary, through the physics of vertical pulling and the human machine, into technique, progression, assessment, injury management, programming, and the professional reference apparatus.

Table 0.3. Ten-part architecture

Part	Title	Chapter span
Part I	Foundations, Vocabulary and Decision Science	Chapters 1–12
Part II	The Physics Engine of Vertical Pulling	Chapters 13–24
Part III	The Human Machine	Chapters 25–36
Part IV	Complete Muscle and Tissue Atlas	Chapters 37–48
Part V	Phase Atlas and Technique Variables	Chapters 49–60
Part VI	Progression From Beginner to Advanced	Chapters 61–72
Part VII	Assessment, Coaching and Correction	Chapters 73–84
Part VIII	Pain, Injury and Return-to-Load	Chapters 85–96
Part IX	Programming by Goal and Population	Chapters 97–108
Part X	Reference Apparatus and Professional Tools	Chapters 109–120

A detailed chapter-level table of contents follows the front matter; each part opens with its own chapter map and closes with a part summary and decision card.

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COMPANION REFERENCE · VARIATION CARDS

Index of Variation Cards

This volume is accompanied by a set of **twenty two-page biomechanics cards**, one for each of the most common chin-up and pull-up variations, reproduced in full at the back of the book. Each card isolates a single variation and carries it from mechanics to correction, so a coach or clinician can move from an observed fault to the specific tissue behind it and the measure that resolves it.

The cards share the reference's decision-science logic: locate the limiting structure, then dose the specific stimulus within tissue tolerance. They are indexed here by theme; each entry gives the grip or classification, the primary mechanical focus, and the page on which the card begins.

Table 0.4. How each card is structured

Element	What it provides
Biomechanics lens	How the variation routes torque and loads tissue.
4 in × 6 in figure	The working position of the variation, annotated.
Working-muscle actions	What each contributing muscle actually does in that pull.
Fault → weakness → correction	The at-fault muscle behind each common error and the measure that loads it.
Diagnostic loop	Observe the fault → locate the weak link → load it directly → retest the standard.
Dosing traffic-light	Green / amber / red logic for loading, regressing and referring.
Credibility & caution	The point at which the decision moves toward referral.

The twenty cards

GRIP VARIATIONS

Card	Variation	Grip / classification	Primary mechanical focus	p.
01	Pronated (overhand) pull-up	Pronated, overhand	Back & scapula; long shoulder moment arm	239
02	Supinated (underhand) chin-up	Supinated, underhand	Elbow flexors; biceps advantage	241
03	Neutral-grip pull-up	Neutral	Balanced; shoulder-friendly default	243
04	Wide-grip pull-up	Pronated, wide	Latissimus/scapula; most shoulder-exposing	245
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RANGE & BODY POSITION

Card	Variation	Grip / classification	Primary mechanical focus	p.
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11	L-sit pull-up	Any grip, legs horizontal	Anti-extension core; hip flexors	259
17	Typewriter pull-up	Wide, lateral traverse	Top-range unilateral traverse	271
20	Behind-the-neck pull-up	Pronated, wide, posterior	High-risk end-range position	277

LOADING & TEMPO

Card	Variation	Grip / classification	Primary mechanical focus	p.
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DYNAMIC / SPORT

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PROGRESSION & REGRESSION

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19	One-arm (& assisted one-arm) pull-up	Single-arm	Apex unilateral strength	275

Muscle attributions on each card are the commonly-associated weaknesses and should always be confirmed against the individual athlete's response. The cards are educational and do not replace individual clinical assessment.

PART I

Chapters 1 – 12

Foundations, Vocabulary and Decision Science

Before mechanics can be applied, the problem must be named. This part fixes the shared vocabulary, defines the movement as a load-transfer decision, and sets the reasoning model used in every part that follows — from the one-sentence standard to the evidence hierarchy that keeps the reference honest.

1 · One sentence

2 · Whole-body

3 · Bar-hand-body

4 · Task families

5 · Grip

6 · Range

7 · The hang

8 · 12 principles

9 · Myths

10 · Lenses

11 · Evidence

12 · Reading it

CHAPTER 1 · PART I — FOUNDATIONS

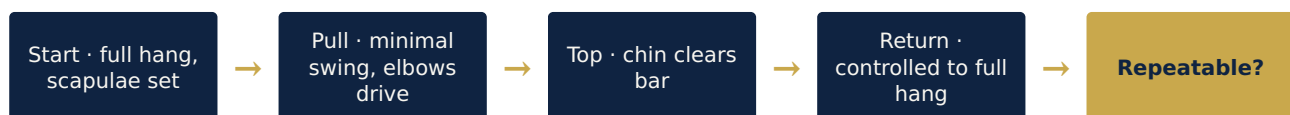
The one-sentence chin-up and pull-up

A chin-up or pull-up is one sentence long: **hang from a fixed bar and raise the body until the chin clears it, then lower under control to a full hang.** Everything else in this book unpacks that sentence — but the sentence itself is the standard. If the athlete cannot define where the repetition starts and finishes, they cannot know whether it improved, and neither can the coach.

The movement is best read not as an exercise but as a *load-transfer decision*. The bar is fixed; the body is the load; the only route through which force can leave the body and reach the bar is the hands. The athlete's task is to organise the hand, wrist, elbow, shoulder, scapula and trunk so force travels a clean path rather than leaking into swing, shrug or compensation.

KEY IDEA

A good repetition should look strong because the problem was well chosen, not because the athlete survived a mismatch. A rep only counts if it can be repeated to the same standard.

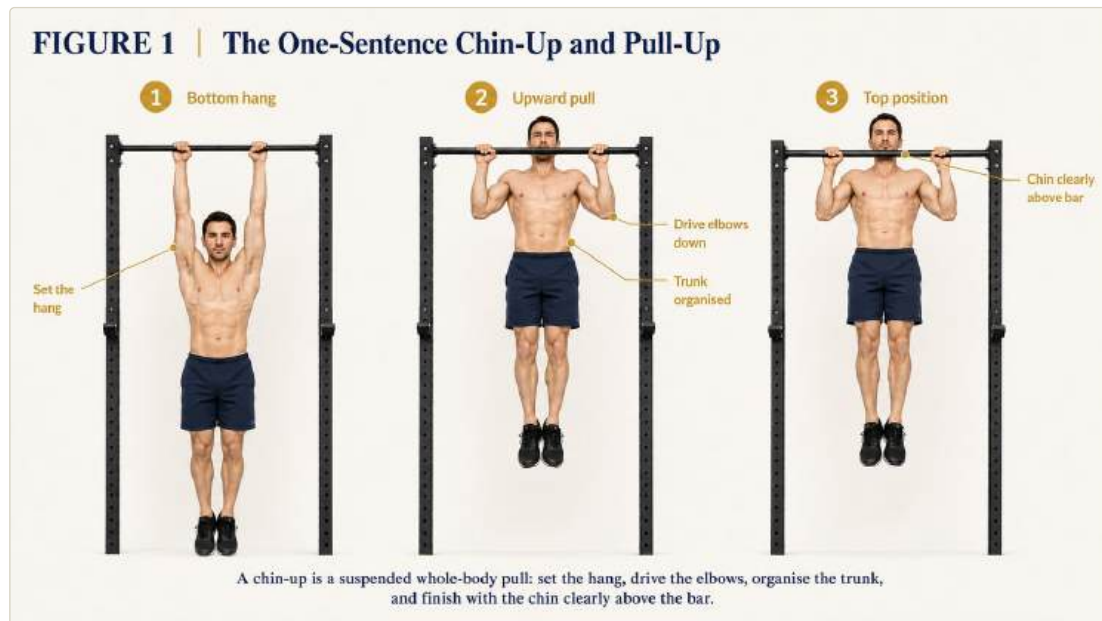


Flowchart 1.1. The one-sentence standard as a repeatable cycle; the final gate asks whether the same standard holds before the rep is counted.

Table 1.1. The one-sentence standard

Point in rep	Pass criterion	Common failure
Start	Full hang; arms straight; scapulae set, not slack.	Starting from a shortened, half-flexed position.
Pull	Body rises with minimal swing; elbows drive down.	Kip or leg-drive substituting for pulling force.
Top	Chin clearly clears the bar (or chest to bar, if specified).	Neck craning to fake the height.
Return	Controlled descent to a full hang.	Dropping into the bottom without control.

FIGURE 1



Navy line-work, gold call-outs, cream ground; each of the four pass criteria annotated on the panel where it is judged.

MMSx coaching translation: define the rep before you count it. One agreed standard for start, top and return turns "do pull-ups" into a measurable, progressable task.

CHAPTER 2 · PART I — FOUNDATIONS

Why vertical pulling is not only a back exercise

The pull-up is filed under "back" in most training plans, and that label quietly limits how it is coached. Mechanically it is a whole-body chain: the latissimus and teres major supply shoulder extension and adduction, but the elbow flexors, the scapular stabilisers, the forearm and grip, and the anti-extension muscles of the trunk all decide whether the rep succeeds. In a supinated grip the biceps and brachialis are heavily involved, not incidentally but as prime contributors (Youdas et al., 2010; Signorile et al., 2002).

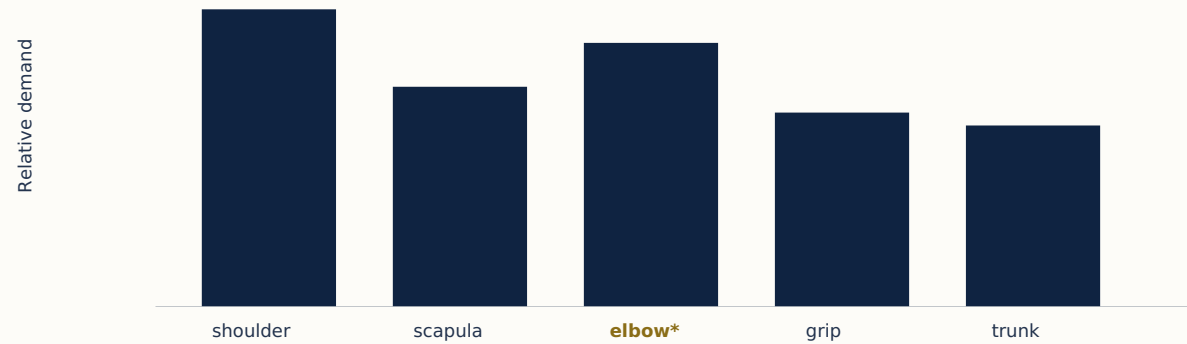
Treating the movement as "just lats" hides the joints where reps are actually lost — usually the elbow at the sticking point, the scapula at the start, or the trunk when the body begins to swing.

KEY IDEA

A pull-up is a chain, and a chain is only as strong as the link that yields first. Coaching the "back" while the elbow or scapula is the limiter wastes the athlete's effort.

Figure 2.1 · Relative contribution by region (illustrative)

SCHEMATIC



*The elbow (gold) is a frequent true limiter, especially in chin-ups — highlighted because it is so often under-coached. Proportions illustrative.

Table 2.1. Regional contributions to a strict pull-up

Region	Primary role	Why it matters
Shoulder (lat, teres major, pec)	Extension and adduction of the humerus.	The main engine of vertical displacement.
Scapula (lower trap, serratus, rhomboids)	Sets and controls the platform on the ribcage.	An unstable scapula leaks force and irritates the shoulder.
Elbow (biceps, brachialis, brachioradialis)	Flexion torque; grip-dependent bias.	Frequent true limiter, especially in chin-ups.
Forearm / grip	Maintains the only force-transfer interface.	Grip failure ends the set regardless of pulling capacity.
Trunk / hips	Anti-extension bracing; controls the body line.	A loose trunk turns pulling into swinging.

EVIDENCE NOTE

Surface-EMG comparisons consistently show substantial elbow-flexor and scapular-muscle involvement across pull-up and pulldown variants, not latissimus alone (Youdas et al., 2010; Sperandei et al., 2009).

FIGURE 2.2**FIGURE 2 | Why Vertical Pulling Is Not Only a Back Exercise**

Vertical pulling is a whole-system suspended task: the hands, shoulders, elbows, trunk, and body line all contribute to the final rep.

Shoulder, scapula, elbow, forearm, trunk colour-mapped on the real figure; palette navy/gold/cream.

MMSx coaching translation: find the yielding link, then train it. If grip or elbow fails first, no amount of "back" work fixes the rep.

CHAPTER 3 · PART I — FOUNDATIONS

The bar-hand-body system

Every vertical pull is a closed kinetic chain with three subsystems: a fixed support (the bar and its mounting), a force-transfer interface (the hand and grip), and a moving mass (the body and its centre of mass). Force generated anywhere in the body can only reach the bar through the hands; the grip is therefore not a detail but the single valve through which the whole task must pass.

Because the support is fixed and the mass is free, the body behaves like a pendulum. Uncontrolled it swings; controlled it travels a near-vertical path. Much of what looks like "poor technique" is simply an un-managed pendulum bleeding force into horizontal motion.

KEY IDEA

Fixed bar, single valve, swinging mass. Organise the hand, quiet the swing, and the force you produce actually reaches the bar instead of leaking sideways.

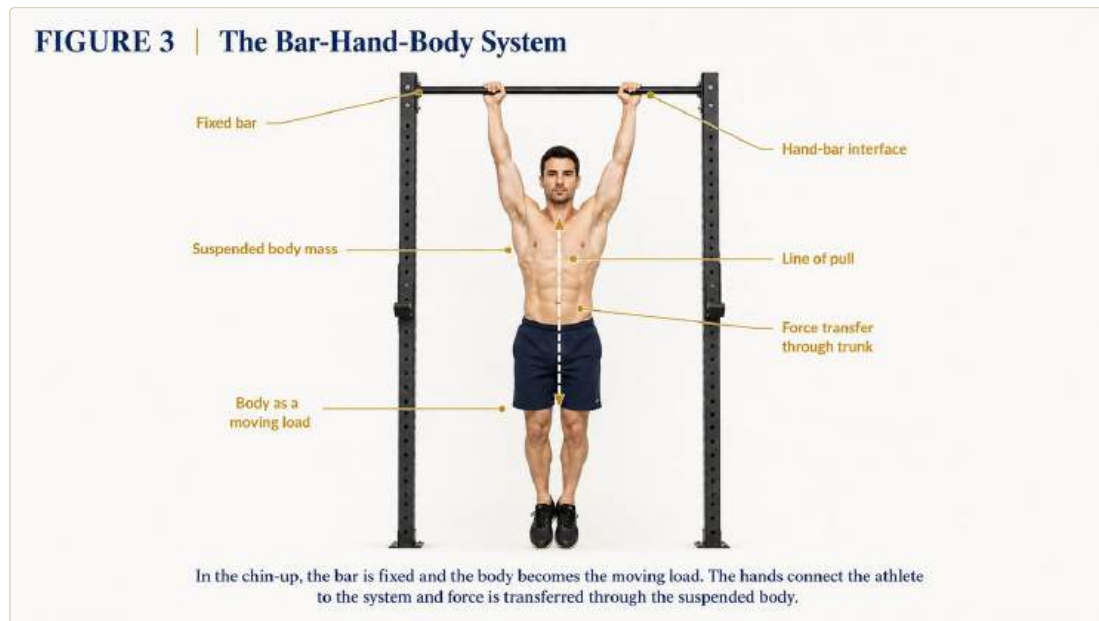


Flowchart 3.1. The closed loop: force leaves the body only through the hands, and the bar's reaction closes the chain.

Table 3.1. The three subsystems

Subsystem	Function	Failure mode
Fixed support (bar)	Provides the immovable reaction point.	Unstable or slippery bar changes the whole task.
Interface (hand / grip)	Transfers all body force to the bar.	Grip fatigue caps performance before the prime movers do.
Moving mass (body / COM)	The load to be raised along a near-vertical path.	Unmanaged swing converts pulling force into oscillation.

FIGURE 3



Show the near-vertical COM path and a greyed swing arc marked "suppress"; gold highlight on the hand-bar interface.

MMSx coaching translation: protect the valve and kill the swing. A secure grip and a quiet body line are worth more than any cue about the "lats".

CHAPTER 4 · PART I — FOUNDATIONS

Strict, assisted, weighted and kipping tasks

"Pull-up" names four different mechanical problems, not four difficulty settings of one. Confusing them is a common programming error: an athlete building strict strength does not benefit from kipping volume, and an athlete rehabilitating a shoulder does not need weighted singles. Each task changes what is being trained and what is being risked.

The strict task is a pure strength-endurance problem. The assisted task reduces the effective load so the pattern can be practised below full capacity. The weighted task raises external demand to drive maximal strength. The kipping task adds a hip-driven impulse that transfers momentum to the bar, trading strictness for cyclical rate — a legitimate skill in its own sport, but a different exposure (Zatsiorsky & Kraemer, 2006).

KEY IDEA

Choose the task to match the goal, not the athlete's mood. Strict builds control, assisted builds access, weighted builds force, kipping builds cyclical capacity — they are not interchangeable.



Flowchart 4.1. Task selection follows the goal, not habit.

Table 4.1. Four task families

Task	Primary stimulus	Best suited to	Chief risk
Strict	Strength-endurance under full body load.	General strength; a clean baseline.	Over-reaching volume as strength plateaus.
Assisted	Reduced load; pattern practice.	Beginners; return-to-load.	Never progressing off assistance.
Weighted	High force; maximal strength.	Advanced athletes with a strict base.	Adding load before mechanics are stable.
Kipping	Hip-driven impulse; cyclical rate.	Sport-specific gymnastics.	High shoulder demand; misuse as a shortcut.

CREDIBILITY & CAUTION

Kipping is not "cheating" and not a beginner regression. It is a distinct, shoulder-intensive skill layered onto — never used to bypass — a strict base.

FIGURE 4**FIGURE 4 | Strict, Assisted, Weighted and Kipping Tasks**

These are related but not identical tasks. Assistance, added load and momentum change the mechanical problem and should not be treated as the same exercise.

Consistent framing across four figures so the task differences read at a glance.

MMSx coaching translation: name the task before you program it. The same word hides four different exposures.

CHAPTER 5 · PART I — FOUNDATIONS

Grip families made exact

Grip is the fastest lever a coach has, because changing hand orientation and width changes the moment arms at the shoulder and elbow without changing the load. Supinated (chin-up), pronated (pull-up), neutral, mixed and varying widths each redistribute the work between the elbow flexors and the latissimus/scapular controllers — a redistribution of *torque*, not merely of "feel" (see Chapter 16).

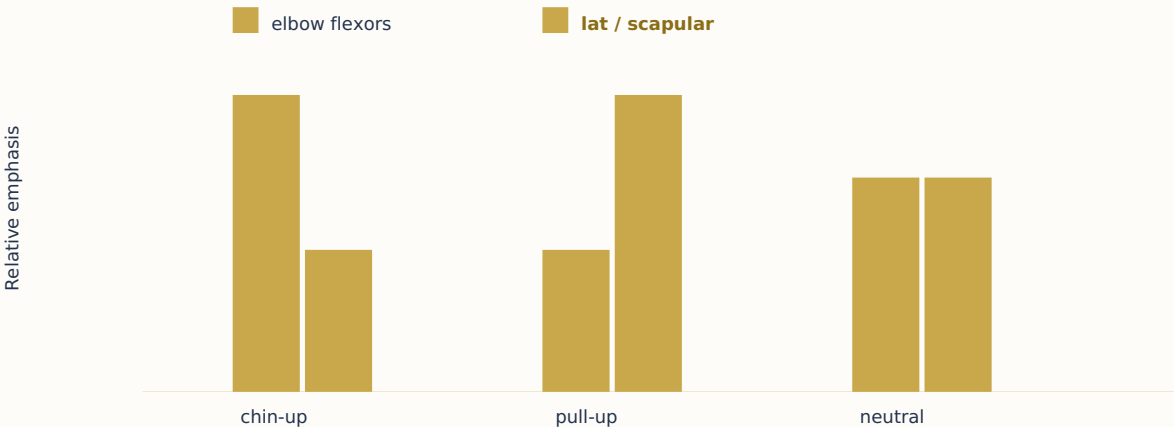
Surface-EMG work across grips and widths shows the pattern reliably: supinated and narrower grips raise elbow-flexor and biceps demand; wider pronated grips increase latissimus and scapular-muscle involvement, with forearm orientation contributing independently of width (Youdas et al., 2010; Signorile et al., 2002; Lusk et al., 2010; Andersen et al., 2014).

KEY IDEA

Grip selects which joint leads the pull. Choose it to route peak demand toward the athlete's tolerant tissue, not by habit or fashion.

Figure 5.1 · Muscular bias by grip (illustrative)

SCHEMATIC



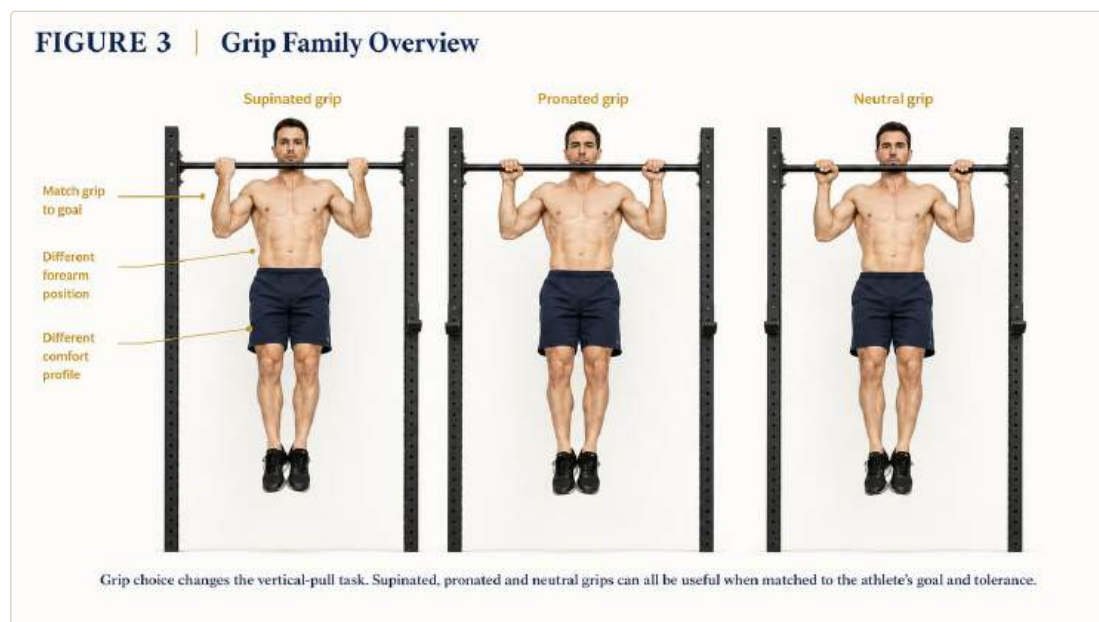
Chin-up biases the elbow flexors; pull-up biases the latissimus and scapular controllers; neutral sits between. Proportions illustrative of the direction shown in EMG literature.

Table 5.1. Grip families and their bias

Grip	Orientation	Muscular bias	Typical use
Chin-up	Supinated (palms toward)	Elbow flexors and biceps emphasised.	Building pulling strength; elbow-tolerant athletes.
Pull-up	Pronated (palms away)	Latissimus and scapular controllers emphasised.	Back-dominant strength; sport carry-over.
Neutral	Palms facing each other	Balanced; often shoulder-friendly.	Low-risk default; irritable shoulders or elbows.
Mixed	One supinated, one pronated	Asymmetric; useful for heavy holds.	Grip-limited heavy work; rotate sides.
Wide vs narrow	Width variation	Wider raises lat/scapular demand; narrower raises flexor demand.	Emphasis shifting within a grip.

EVIDENCE NOTE

No single grip is universally superior; the literature supports selection by goal and tolerance, since grip and forearm orientation shift activation predictably (Andersen et al., 2014; Lusk et al., 2010).

FIGURE 5.2

Arrows indicate the muscular bias per grip; align with the schematic above.

MMSx coaching translation: when a joint complains, change the grip before you change the exercise. It is the cheapest way to move the load.

CHAPTER 6 · PART I — FOUNDATIONS

Range-of-motion standards

A repetition means nothing until its range is defined. "Full range" for a pull-up runs from a complete hang with straight arms to the chin (or chest) clearing the bar. Partial reps are not automatically inferior — they can deliberately target a weak zone — but they must be declared, not smuggled in as fatigue shortens the range.

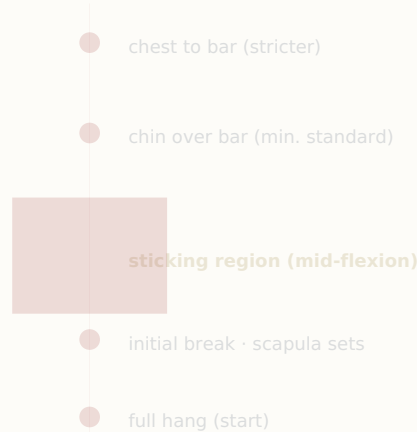
Full-range work loads the shoulder through its greatest excursion and trains the sticking region directly; it also demands the most scapular control at the bottom (Prinold & Bull, 2016). Where hypertrophy or strength across the range is the goal, honest full-range reps are generally preferable, while targeted partials are a tool, not a default (Schoenfeld et al., 2017).

KEY IDEA

Define the range, then count. A rep whose range quietly shrinks under fatigue is a different rep — and a dishonest record of capacity.

Figure 6.1 · The range ladder (bottom to top of the pull)

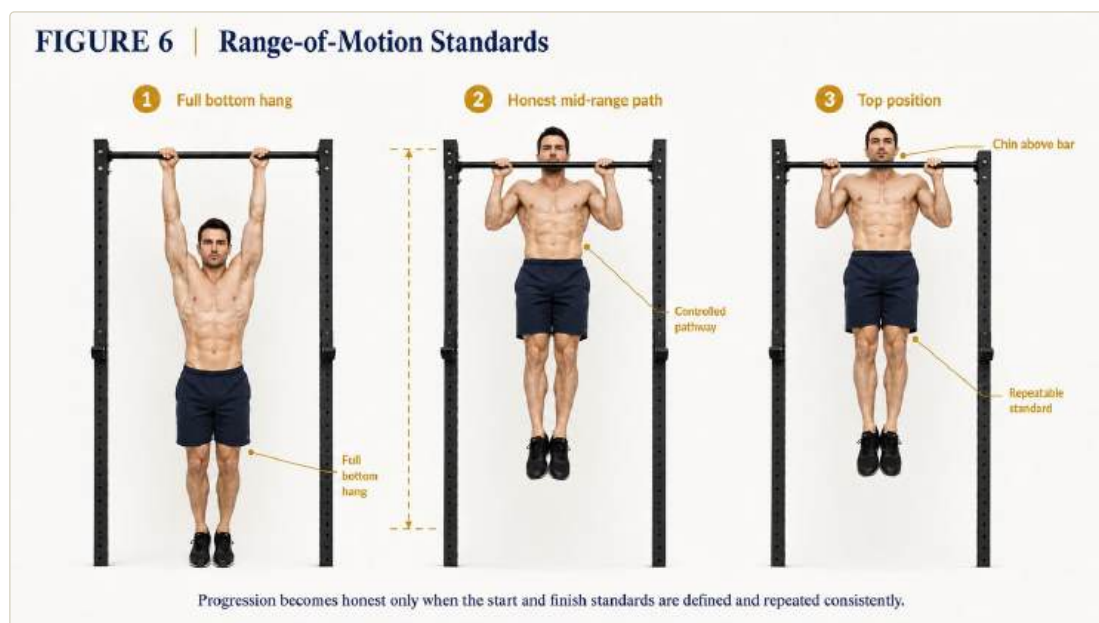
SCHEMATIC



Five declared checkpoints along the vertical path; the shaded band is the sticking region where most reps fail.

Table 6.1. Range checkpoints

Checkpoint	Definition	Coaching note
Full hang	Arms straight, shoulders loaded, scapulae set.	The honest start; not a half-flexed cheat position.
Initial break	Scapular depression begins the pull.	Set the platform before bending the elbows.
Sticking region	Mid-flexion; longest external moment arm.	Where most reps fail; target it deliberately.
Chin over bar	Chin clearly above the bar.	The minimum standard for a counted rep.
Chest to bar	Sternum reaches bar height.	A stricter standard; specify when required.

FIGURE 6.2

Align checkpoint heights with the range-ladder schematic above.

MMSx coaching translation: shrinking range is the first sign of fatigue. When the range drops, the set is telling you to stop, not to keep counting.

CHAPTER 7 · PART I — FOUNDATIONS

The active hang as a preparation decision

The hang is not one thing. A *passive* hang lets the shoulders rise toward the ears and loads the connective tissue of the shoulder and the grip; an *active* hang sets the scapulae down and back, loading the pulling muscles and preparing the platform for the first rep. Choosing between them is a deliberate decision about what the hang is *for*.

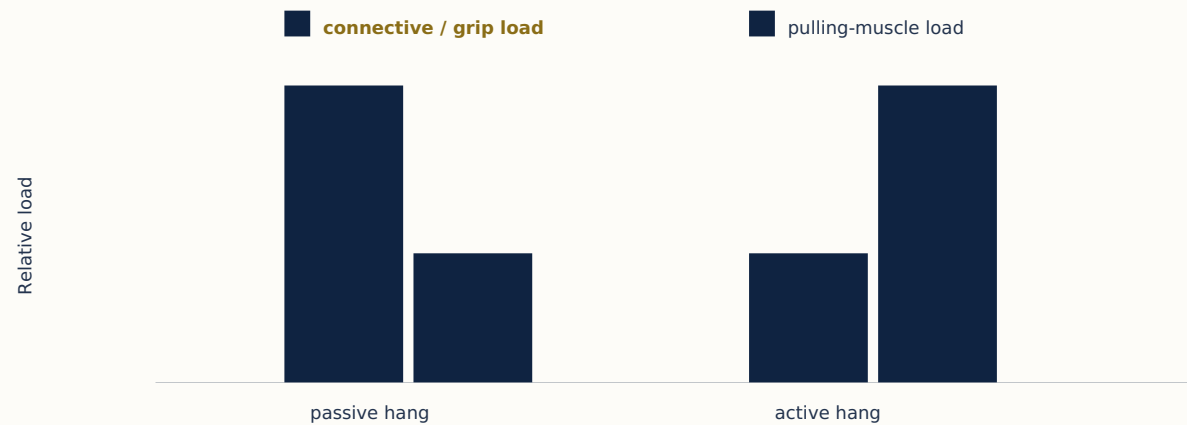
Used well, a passive hang can be a decompression and grip-endurance tool; used by default at the start of a pull, it leaves the scapula unset and invites the shoulder to work from an uncontrolled position (Ludewig & Reynolds, 2009; Prinold & Bull, 2016). The active hang is the correct starting platform for strict pulling.

KEY IDEA

Decide what the hang is for before you hang. Passive to decompress and build grip; active to start a strong, organised pull.

Figure 7.1 · Where the load goes: passive vs active hang

SCHEMATIC



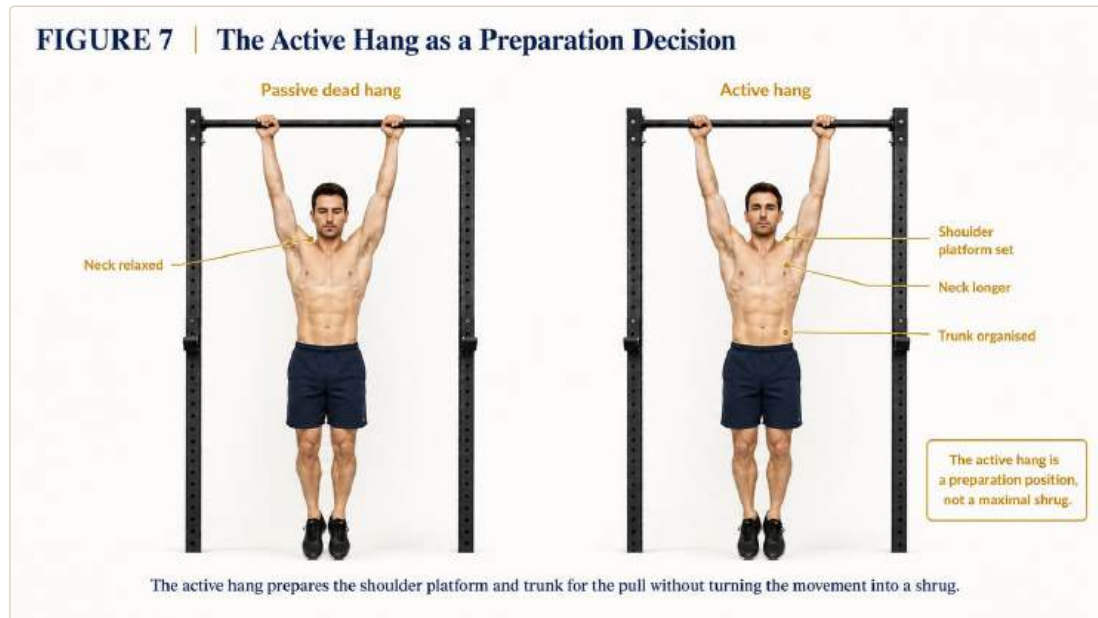
The passive hang loads connective tissue and grip; the active hang loads the pulling muscles and sets the platform. Illustrative.

Table 7.1. Passive vs active hang

Feature	Passive hang	Active hang
Scapula	Elevated, unset.	Depressed and set on the ribcage.
Main load	Connective tissue and grip.	Pulling muscles and scapular controllers.
Best use	Decompression, grip endurance, mobility.	Starting platform for strict reps.
Watch for	Irritable shoulders may dislike end-range hang.	Fatigue that lets the scapula slip up mid-set.

CREDIBILITY & CAUTION

For an irritable or unstable shoulder, do not prescribe long passive hangs by default; the end-range position may be provocative. Choose the hang to the tissue, and reassess.

FIGURE 7.2

Contrast scapular elevation against depression clearly; gold call-out on the set scapula.

MMSx coaching translation: "set the shoulders" is the first rep cue. An active hang converts a dangle into a loaded, ready position.

CHAPTER 8 · PART I — FOUNDATIONS

Twelve principles that explain most errors

Most coaching errors in vertical pulling are not exotic. They are repeated violations of a small set of principles. Learn the twelve below and the majority of faults become predictable — and correctable with one change rather than five cues.

KEY IDEA

Errors cluster. Twelve principles cover most of what goes wrong; diagnose against the list before inventing a new cue.

1. **Position before power.** Organise the scapula and trunk before demanding force.
2. **Load before technique collapses.** Reduce demand before the pattern breaks, not after.
3. **One variable at a time.** Change grip, load, tempo or volume singly, so cause is knowable.
4. **Range honesty.** Count only reps that meet the declared range.
5. **The valve is the grip.** Grip failure ends the set regardless of pulling strength.
6. **Kill the swing.** A managed body line keeps force vertical.
7. **Symptom-led dosing.** Progress on a traffic-light, not all-or-nothing.
8. **Match task to goal.** Strict, assisted, weighted and kipping are different problems.
9. **Grip routes torque.** Use hand orientation to move demand between elbow and shoulder.
10. **Recovery is a rep-standard too.** The next session must be repeatable in quality.
11. **Regress the angle, not just the effort.** Target the failure point, not the whole rep.
12. **Retest before you progress.** Confirm the same standard holds before adding demand.



Flowchart 8.1. Diagnose against the principles, then correct with the smallest useful change.

FIGURE 8



Navy/gold on cream; card-stock proportions so coaches can carry it.

MMSx coaching translation: when a rep looks wrong, name the principle it broke. The correction usually follows directly from the principle.

CHAPTER 9 · PART I — FOUNDATIONS

Myths that block progress

Several durable myths quietly cap athletes' pulling progress. Each has a grain of truth, which is why it persists; each also has a mechanical correction. The point is not to mock the myth but to replace it with a decision that actually helps.

KEY IDEA

A myth survives because it is half-right. Keep the grain of truth, discard the false conclusion, and coach the correction.

Hear the myth



Keep the grain of truth



Discard the false conclusion



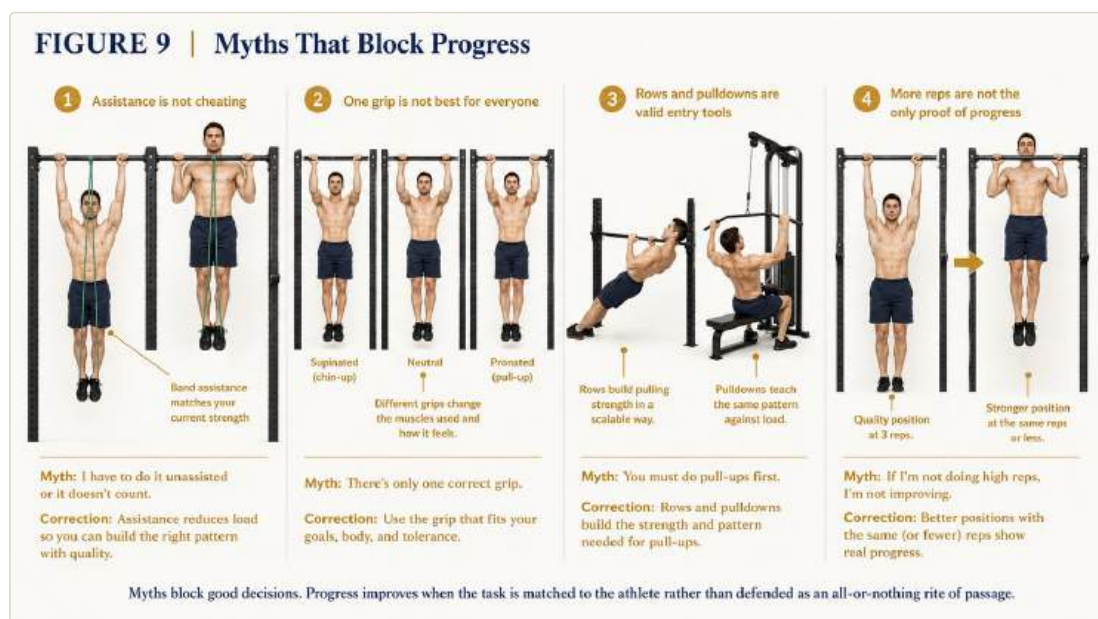
Coach the correction

Flowchart 9.1. Replace the decision the myth drives, not the belief itself.

Table 9.1. Common myths and their corrections

Myth	Grain of truth	Mechanical correction
"Pull-ups are only a back exercise."	The lat is a major mover.	The elbow, scapula, grip and trunk decide most reps (Youdas et al., 2010).
"Wide grip is best for lats."	Wider grips can raise lat demand.	Differences are modest and grip-tolerance dependent; not universally superior (Andersen et al., 2014).
"More reps is always better."	Volume drives adaptation up to a point.	Quality range and recovery cap useful volume (Schoenfeld et al., 2017).
"Kipping is cheating."	Kipping is not a strict rep.	It is a distinct, valid skill — not a regression, not a shortcut.
"Pain means stop forever."	Some pain warrants caution.	Use symptom-led dosing; regress the exposure, refer red flags.

FIGURE 9



Left column desaturated, right column in the house gold — reads as "replace this with that".

MMSx coaching translation: don't argue with the myth — replace the decision it drives. Athletes change behaviour, not beliefs, when the correction works.

CHAPTER 10 · PART I — FOUNDATIONS

Reader lenses: beginner, coach, clinician, athlete, researcher

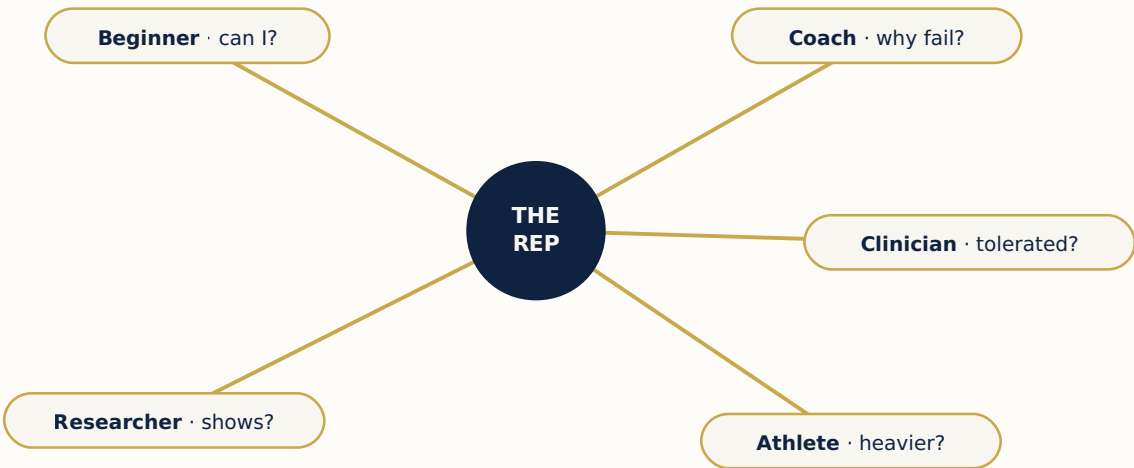
The same repetition answers a different question depending on who is watching it. The beginner asks whether they can do it; the coach asks why it failed; the clinician asks whether the tissue tolerated it; the athlete asks how to make it heavier; the researcher asks what it demonstrates. None is wrong — but each reads different signals from the identical event.

KEY IDEA

One movement, five questions. Knowing which question you are asking decides which signal matters.

Figure 10.1 · One rep, five lenses

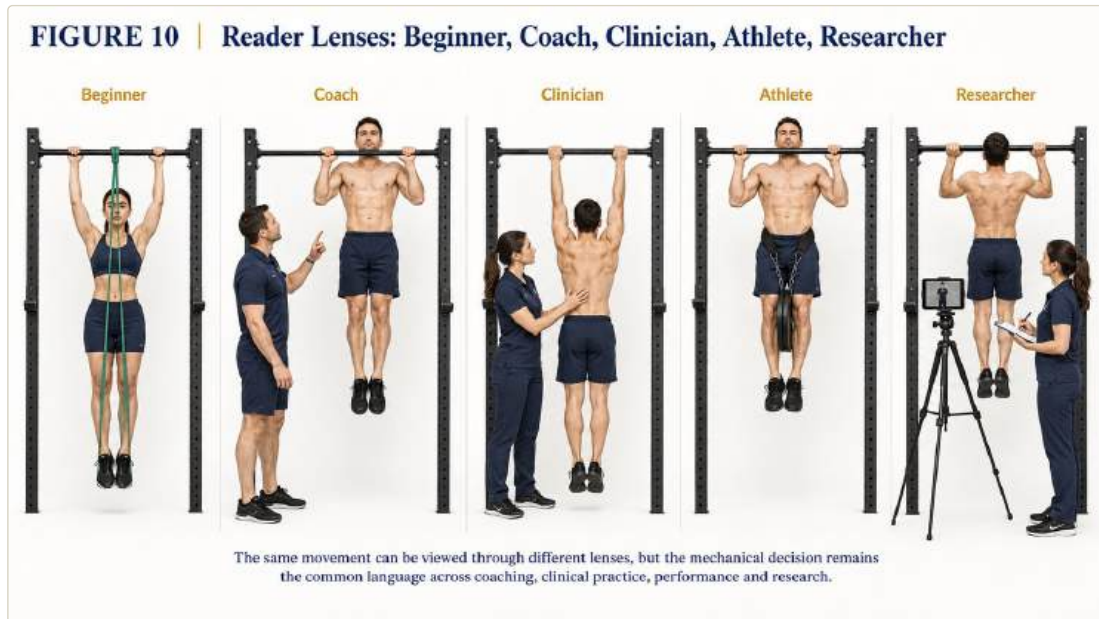
SCHEMATIC



The identical event radiates five distinct questions; each lens attends to a different signal.

Table 10.1. What each lens reads

Lens	Core question	Key signal	Typical decision
Beginner	Can I complete it safely?	Completion and confidence.	Choose an accessible entry point.
Coach	Why did it fail?	Failure angle and pattern.	Apply the smallest useful regression.
Clinician	Did the tissue tolerate it?	Symptom behaviour and irritability.	Adjust dose; refer red flags.
Strength athlete	How do I raise force?	Bar speed and load progression.	Add weight while preserving mechanics.
Researcher	What does it demonstrate?	Reproducibility and measurement.	Control variables; report honestly.

FIGURE 10.2

Mirror the hub schematic with a real figure at the centre.

MMSx coaching translation: before you judge a rep, decide which lens you're using. The same set can be a success and a warning at once.

CHAPTER 11 · PART I — FOUNDATIONS

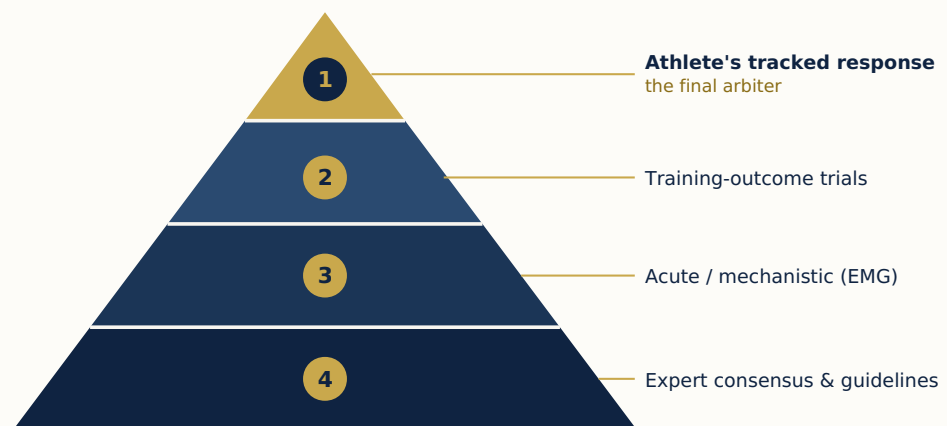
Evidence hierarchy for vertical pulling

Not all evidence answers the same question, and the most common error is reading a mechanistic finding as if it were an outcome. A high EMG amplitude tells you a muscle was active in a task; it does not, on its own, tell you the task builds more strength or size (Youdas et al., 2010; Schoenfeld et al., 2017). Weighting evidence correctly is what keeps a reference honest.

The practical hierarchy runs from the athlete's own tracked response, through controlled training-outcome trials, to mechanistic and acute lab data, with expert consensus filling gaps. Each tier answers a different question, and the individual response is the final arbiter of a training decision (Wulf, 2013; Haff & Triplett, 2016).

KEY IDEA

Match the evidence to the question. Mechanistic data explains *how*; outcome data shows *whether*; the athlete's response decides *for whom*.

Figure 11.1 · The working evidence hierarchy**SCHEMATIC**

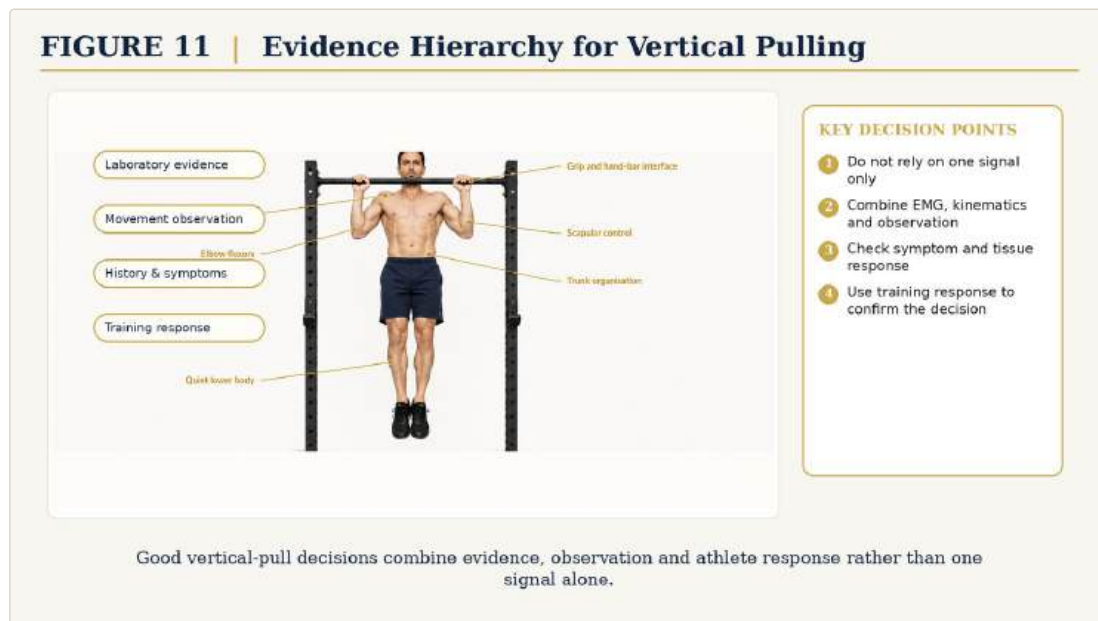
The athlete's tracked response sits at the apex as the final arbiter; mechanistic data forms the broad, cautious base.

Table 11.1. A working evidence hierarchy

Tier	What it answers well	Limitation
The athlete's tracked response	Whether it works for this person.	Single case; needs honest records.
Training-outcome trials	Whether it changes strength/size on average.	Group means hide individual variation.
Acute / mechanistic (EMG, kinematics)	How a task loads tissue in the moment.	Activation ≠ adaptation.
Expert consensus / guidelines	Reasonable defaults where data is thin.	Opinion-weighted; can lag evidence.

EVIDENCE NOTE

Treat acute EMG comparisons as hypotheses about emphasis, not proof of superiority; corroborate with outcome data and the athlete's response before making a programming claim (Schoenfeld et al., 2017).

FIGURE 11

Evidence hierarchy for vertical pulling.

MMSx coaching translation: "a study showed high activation" is a starting hypothesis, not a verdict. Ask what the athlete's own data says next.

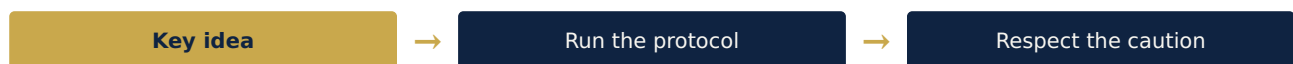
CHAPTER 12 · PART I — FOUNDATIONS

How to read the full reference

This book is built to be navigated, not read cover-to-cover under duress. Every chapter uses the same furniture, so once the pattern is learned, any chapter can be read in the reader's own order. The recurring elements each do a specific job; using them as intended is how the reference earns its keep.

KEY IDEA

The structure is constant so the reasoning, not the layout, carries the learning. Learn the furniture once; then read in any order the task demands.



Flowchart 12.1. The three elements that alone will carry most sessions.

Table 12.1. The recurring chapter elements

Element	What it gives you	How to use it
Plain-language opening	The idea in ordinary words.	Read first; orient before detail.
Key idea box	The one thing to retain.	The line to remember if nothing else.
Decision map / tables	Variables and their levers.	Use to choose an action, not just to read.
Schematic graph / chart	The relationship made visible.	Read the shape; confirm the direction of effect.
Evidence note	What research supports and what it doesn't.	Weight your confidence; check the citation.
Credibility & caution	The limit of the claim.	Stop before over-reaching the evidence.
Flowchart / protocol	The applied procedure.	Run it at the bar; make decisions repeatable.
Integrated figure	The mechanics on a real human.	Pair with the text; confirm the pattern.
Coaching translation	The takeaway in coach's language.	Carry it into the session.

With the vocabulary and the reading method now fixed, Part II turns to the physics engine of vertical pulling — force, gravity, moment arms and torque — and puts numbers on the demands this part has only named.

FIGURE 12

FIGURE 12 | How to Read the Full Reference

The same movement can be read through beginner, coaching, clinical, athletic and research lenses.

An annotated key so a first-time reader can decode any chapter at a glance.

MMSx coaching translation: read the key idea, run the protocol, respect the caution. Those three elements alone will carry most sessions.

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PART II

Chapters 13 – 24

The Physics Engine of Vertical Pulling

Part I named the demands; Part II measures them. Force, gravity, moment arms, torque, work, power, impulse and velocity are treated as quantities that can be estimated, plotted and used to make decisions — with worked numbers a coach can reproduce at the bar.

13 · Load

14 · Gravity

15 · Moment arms

16 · Torque

17 · Work & energy

18 · Power & RFD

19 · Impulse

20 · Centre of mass

21 · Velocity curve

22 · Bands

23 · Machines

24 · Worked calc

CHAPTER 13 · PART II — PHYSICS ENGINE

External load: body mass, added weight and assistance

The load in a vertical pull is the body itself, adjusted by whatever is added or subtracted at the belt or the band. The useful quantity is the **net effective load**: body weight, minus assistance, plus external weight. Because the forearms and hands do not translate upward with the body, the effective lifted mass is slightly less than total body mass — commonly modelled at roughly 90–95% of body weight for a strict pull (Zatsiorsky & Kraemer, 2006; Winter, 2009). For coaching purposes the whole-body approximation is adequate, but the correction matters when comparing loads precisely.

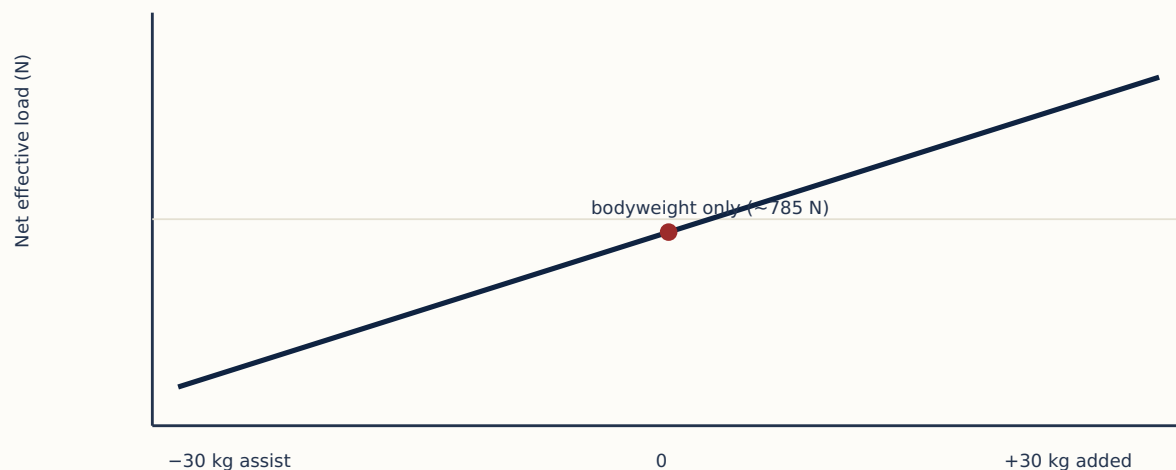
Assistance and added weight are the two levers that move net load without changing the pattern. Understanding where each sits on the load continuum lets a coach place an athlete at a demand they can meet with clean mechanics, then move them along it deliberately.

KEY IDEA

Programme the *net effective load*, not the exercise name. Assistance and added weight are a single continuous axis; the athlete's job is always to solve the load actually presented.

Figure 13.1 · Net effective load across the assistance-loading continuum

SCHEMATIC



Net load rises linearly from heavy assistance (left) to heavy added weight (right); the marked point is unloaded body weight for an 80 kg athlete.

WORKED CALCULATION · NET EFFECTIVE LOAD

80 kg athlete. Band assistance ≈ 20 kg at the bottom; belt adds 10 kg.

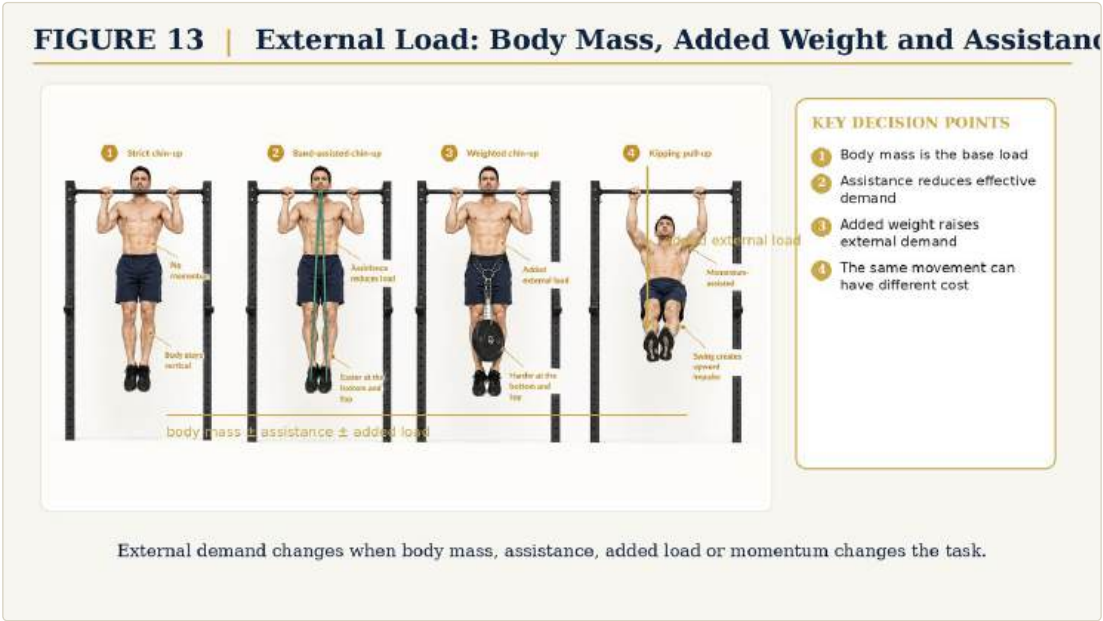
Assisted: $(80 - 20) \cdot 9.81 \approx \mathbf{589\text{ N}}$ | Weighted: $(80 + 10) \cdot 9.81 \approx \mathbf{883\text{ N}}$

A single athlete can be programmed across a $\sim 294\text{ N}$ ($\approx 30\text{ kg}$) span of net load without changing the movement — the basis of linear progression on the pull-up.

Table 13.1. The load continuum

Setting	Net effect	Primary use
Heavy assistance	Net load well below body weight.	First reps; return-to-load.
Light assistance	Net load just below body weight.	Bridging to the first strict rep.
Body weight	Net load $\approx 0.9\text{--}1.0 \times \text{BW}$.	The strict baseline.
Added weight	Net load above body weight.	Maximal-strength development.

FIGURE 13



External load: body mass, added weight and assistance.

MMSx coaching translation: write the net load in newtons or kilograms, not "assisted" or "weighted". One number makes progression legible.

CHAPTER 14 · PART II — PHYSICS ENGINE

Gravity and the fixed overhead support

Gravity supplies a constant downward force of $m \cdot g$ through the centre of mass; the bar supplies the equal and opposite reaction that makes the pull possible (Newton's third law). At a still hang the bar reaction equals body weight. The moment the athlete accelerates upward, the reaction rises to $m \cdot (g + a)$ — which is why an explosive pull loads the hands, wrists and bar mount more than a slow one, even at identical body weight (Winter, 2009).

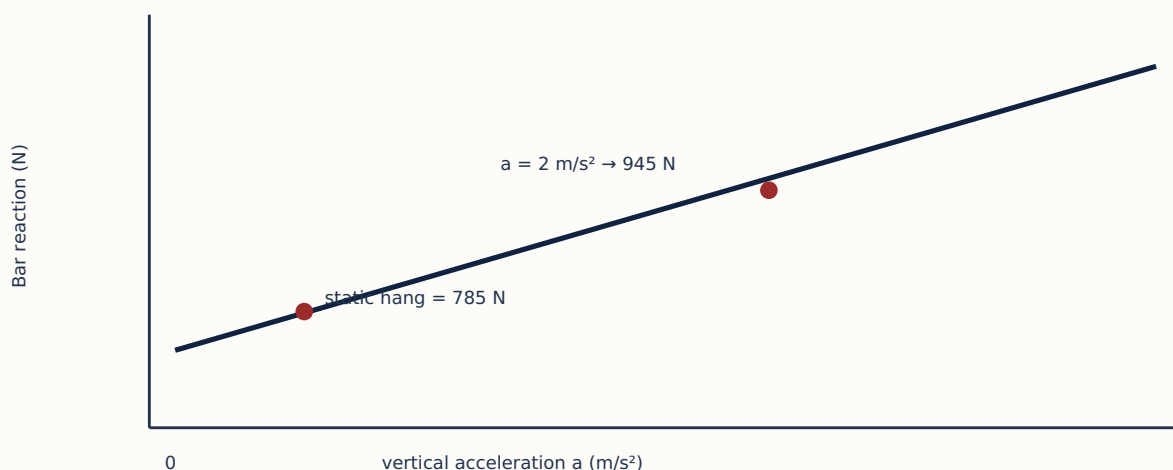
The direction of the gravitational force never changes: it is always vertical, through the centre of mass. Every moment arm in the following chapters is measured against this fixed vertical line.

KEY IDEA

Weight is constant and vertical; the *support reaction* is not. Acceleration adds to the load the hands and bar must carry, so tempo is a loading decision, not just a tempo decision.

Figure 14.1 · Bar reaction force vs vertical acceleration (80 kg)

SCHEMATIC



Support reaction = $m(g + a)$. At rest it equals body weight; upward acceleration raises it proportionally.

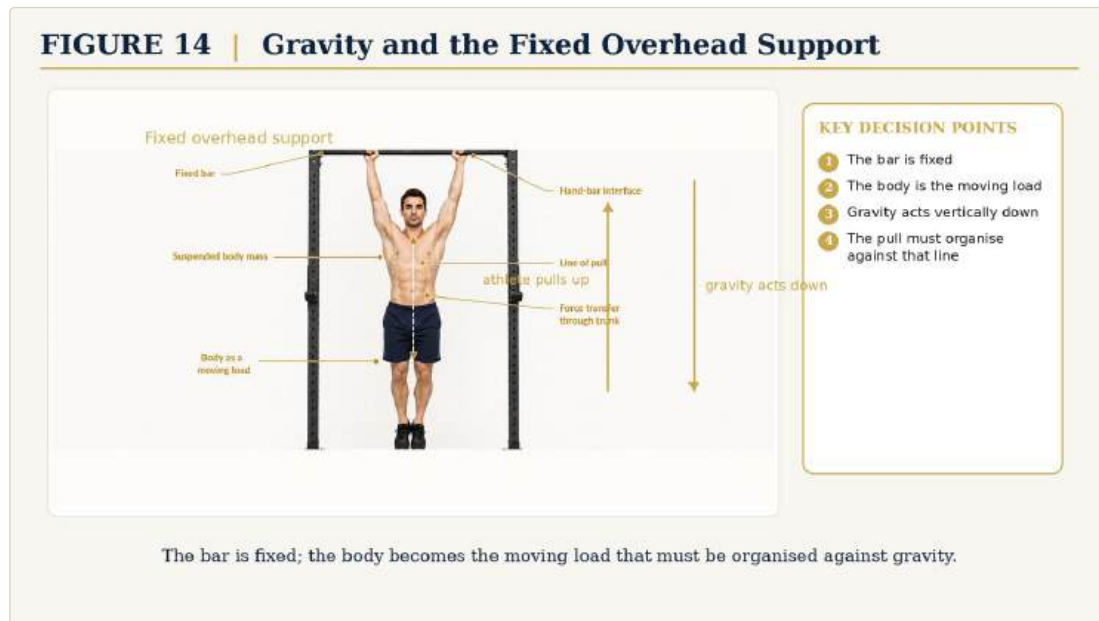
WORKED CALCULATION · DYNAMIC SUPPORT REACTION

Static: $F = m \cdot g = 80 \cdot 9.81 = \mathbf{785 \text{ N}}$

Accelerating up at 2 m/s^2 : $F = 80 \cdot (9.81 + 2) \approx \mathbf{945 \text{ N}}$

A fast pull adds ~20% to peak grip and bar-mount load here — relevant when programming explosive work or checking equipment limits.

FIGURE 14



Gravity and the fixed overhead support.

MMSx coaching translation: "pull faster" is also "load heavier". Explosive intent raises the real force on the hands and the bar, not only bar speed.

CHAPTER 15 · PART II — PHYSICS ENGINE

Moment arms at the shoulder, elbow and wrist

A moment arm is the perpendicular distance from a joint axis to a force's line of action; it converts force into torque. Two kinds matter. The **external** moment arm is the horizontal distance from the joint to the vertical line of gravity — it decides how much torque the joint must overcome. The **internal** moment arm is the distance from the joint to a muscle's line of pull — it decides how much force that muscle must produce to answer the torque. Because internal moment arms are small (centimetres), muscle forces are always far larger than the external load.

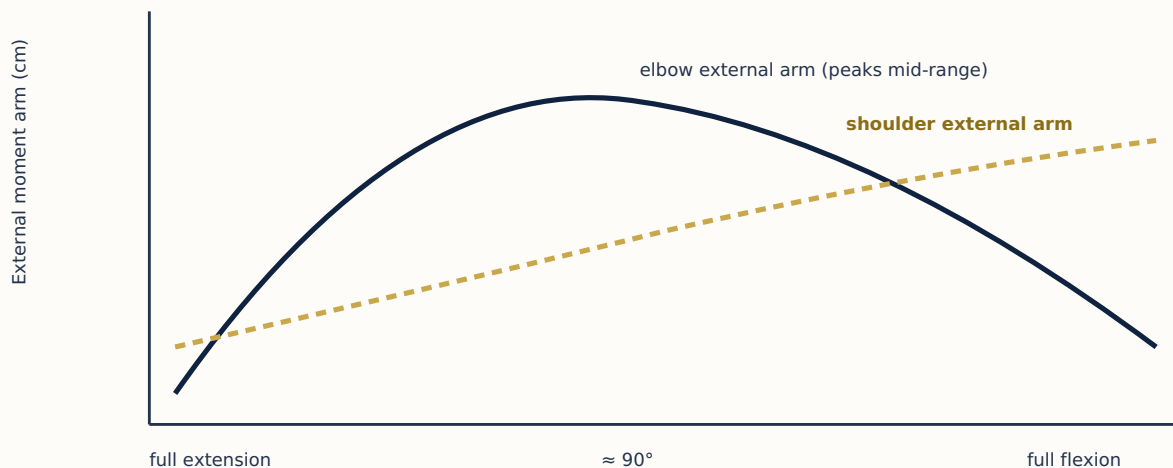
Both change continuously with joint angle. At the elbow, flexor moment arms peak near mid-flexion — the biceps internal moment arm is largest around 90–100° and falls toward full extension and full flexion (An et al., 1981; Murray et al., 1995). At the shoulder, the moment arms of the latissimus and teres major vary with elevation angle (Ackland et al., 2008; Kuechle et al., 1997). These curves, not raw strength, explain where the pull is hard.

KEY IDEA

Torque is force $\times$ moment arm. The external moment arm sets the demand; the internal moment arm sets the muscular cost. The rep is hardest where the external arm is long and the internal arm is short at the same time.

Figure 15.1 · External moment arm vs elbow flexion angle

SCHEMATIC



Representative curves. The elbow's external moment arm peaks in the mid-range — the origin of the sticking region addressed in Chapters 16 and 21.

Table 15.1. Representative internal moment arms (illustrative)

Muscle	Joint action	Approx. peak arm	Source basis
Biceps brachii	Elbow flexion	~3.5–4.7 cm near 90–100°	An et al. (1981); Murray et al. (1995)
Brachialis	Elbow flexion	~1.8–2.0 cm	Murray et al. (1995)
Brachioradialis	Elbow flexion	Longer toward extension	An et al. (1981)
Latissimus / teres major	Shoulder extension/adduction	Varies with elevation	Ackland et al. (2008); Kuechle et al. (1997)

CREDIBILITY & CAUTION

Moment-arm magnitudes vary with individual anatomy, forearm rotation and measurement method. Use these values to reason about *where* demand peaks, not as fixed constants for any one athlete.

FIGURE 15.2



Overlay the vertical line of gravity through the centre of mass and the horizontal external moment arm at the elbow; annotate d in centimetres. Navy line-work, gold call-out.

MMSx coaching translation: the hard point of the pull is a geometry problem, not a willpower problem. It sits where leverage is worst, and geometry is what you change first.

CHAPTER 16 · PART II — PHYSICS ENGINE

Torque management through the pull

Strength in a pull is decided by how much **joint torque** the athlete must overcome at each instant, and whether the muscles crossing that joint can supply an equal internal torque. Torque is the external force multiplied by its moment arm (Chapter 15). Body mass is fixed within a set, but posture, grip and bar path continuously change the leverage through which that mass acts — so torque management is the management of geometry (Zatsiorsky & Kraemer, 2006).

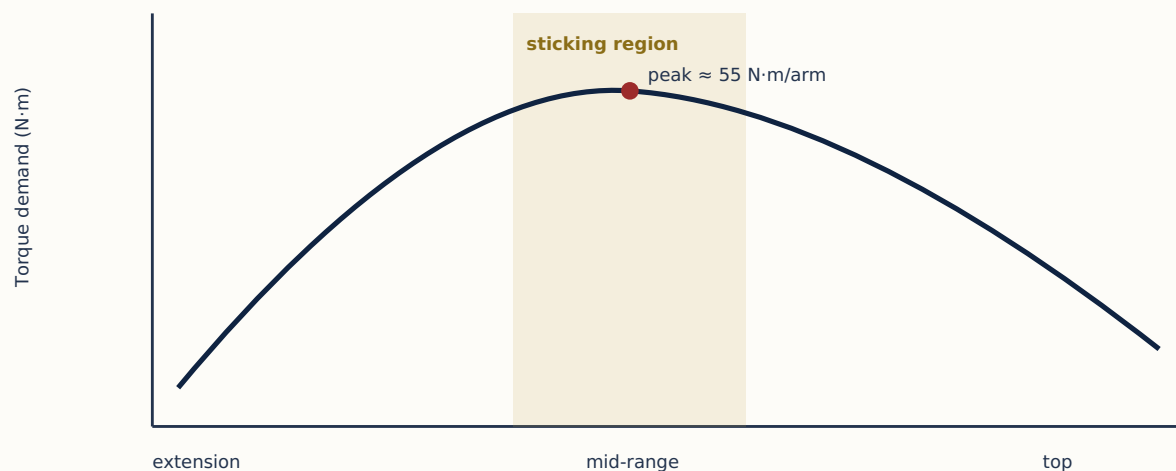
A strict pull is two coupled torque tasks that peak at different moments: elbow-flexion torque, biased by grip toward the biceps and brachialis, and shoulder extension/adduction torque, led by the latissimus and teres major with scapular control from the lower trapezius and serratus anterior (Prinold & Bull, 2016; Youdas et al., 2010). Grip selects which joint leads (Chapter 5).

KEY IDEA

Force is what the muscle makes; torque is what the joint must beat. A pull fails where the external moment arm is longest relative to the available internal moment — geometry first, effort second.

Figure 16.1 · Elbow-flexion torque demand vs elbow angle

SCHEMATIC



Torque demand tracks the external moment arm, peaking mid-range where most reps fail.

WORKED CALCULATION · ELBOW-FLEXION TORQUE AT THE STICKING REGION

$$W = m \cdot g = 80 \cdot 9.81 = \mathbf{785\text{ N}} \rightarrow \text{per arm} \approx 785/2 = \mathbf{393\text{ N}}$$

$$\tau_{\text{ext}} = F \cdot d = 393 \cdot 0.14 \approx \mathbf{55\text{ N}\cdot\text{m}} \text{ per elbow}$$

$$F_{\text{muscle}} = \tau_{\text{ext}} / d_{\text{int}} = 55 / 0.035 \approx \mathbf{1\,570\text{ N/arm}}$$

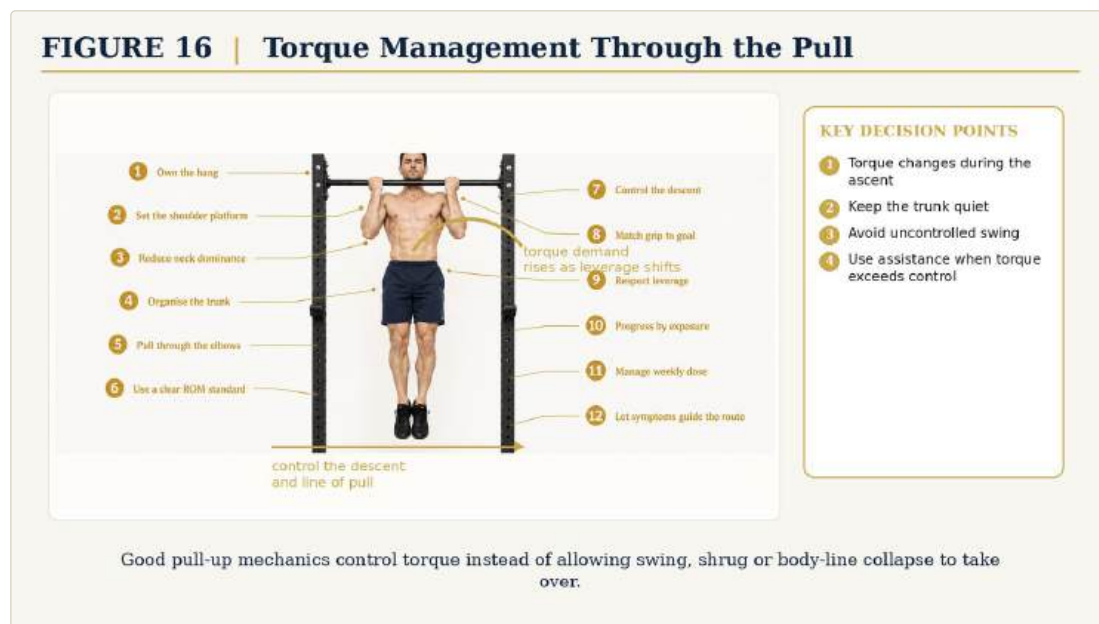
The ~4:1 internal-force penalty explains why the mid-range is hardest and why grip choice, which shifts the flexor moment arm and line of pull, changes perceived difficulty.



Flowchart 16.1. Torque-management decision path.

EVIDENCE NOTE

Grip and hand orientation reliably shift which joint leads: supinated grips raise elbow-flexor demand, wider pronated grips raise latissimus and scapular involvement (Youdas et al., 2010; Signorile et al., 2002; Andersen et al., 2014). Use this to select the torque distribution, not to crown one grip "best".

FIGURE 16

Torque management through the pull.

MMSx coaching translation: you cannot make an athlete lighter inside a set, but you can change the lever the weight acts through. Route the peak to the joint they tolerate, and load that angle.

CHAPTER 17 · PART II — PHYSICS ENGINE

Work, energy and mechanical cost

Mechanical work is force through distance: to raise the centre of mass by a height h , the concentric phase does $W = m \cdot g \cdot h$ of work against gravity (Winter, 2009). For a full pull the COM rises by roughly the range of motion — about 0.6–0.75 m depending on limb length. The eccentric phase returns that energy, which is why lowering feels easier and costs less metabolically, even though it still loads tissue.

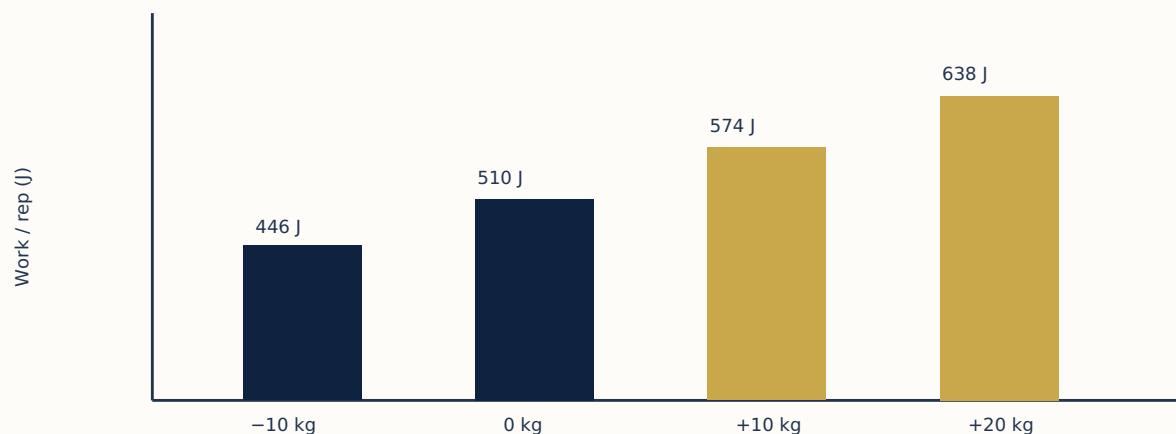
Adding external load raises the work per rep proportionally; assistance lowers it. Total session work — the sum across reps and sets — is a cleaner training-dose variable than "sets × reps" alone, because it folds in load and range.

KEY IDEA

Count work, not just reps. Work per rep ($m \cdot g \cdot h$) captures load and range together and makes two different sessions genuinely comparable.

Figure 17.1 · Concentric work per rep vs added load (80 kg, $h = 0.65$ m)

SCHEMATIC



Work per concentric rep scales linearly with net load at fixed range.

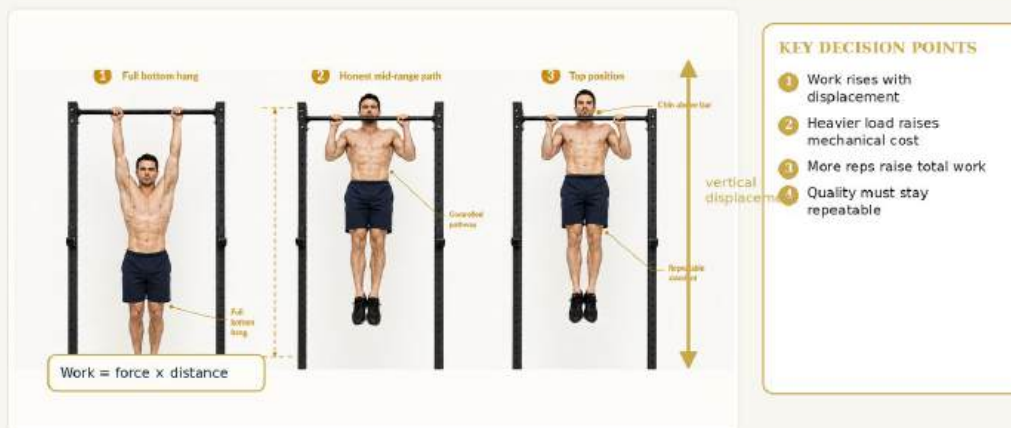
WORKED CALCULATION · WORK PER REP AND PER SET

$$W_{\text{rep}} = m \cdot g \cdot h = 80 \cdot 9.81 \cdot 0.65 \approx \mathbf{510 \text{ J}}$$
 (bodyweight, concentric)

$$\text{Set of 8: } 8 \cdot 510 \approx \mathbf{4\,080 \text{ J} \approx 4.1 \text{ kJ}}$$

At +20 kg the same 8 reps do ≈ 5.1 kJ — a 25% larger mechanical dose from load alone, before any change in rep count.

FIGURE 17

FIGURE 17 | Work, Energy and Mechanical Cost

Mechanical work rises with force, distance and repeated exposure; progress needs honest range and repeatable control.

Work, energy and mechanical cost.

MMSx coaching translation: if you want to compare a light high-rep day with a heavy low-rep day, compare their work. Reps alone hide the real dose.

CHAPTER 18 · PART II — PHYSICS ENGINE

Power and rate of force development

Power is the rate of doing work — force multiplied by velocity, or work divided by time. The same rep done faster produces more power at the same work. Because force and velocity trade off against each other, mechanical power peaks at an intermediate load, not at maximum force or maximum speed (Cormie et al., 2011). Rate of force development (RFD) — how quickly force rises — governs the initial break from the hang and the ability to drive through the sticking region before deceleration.

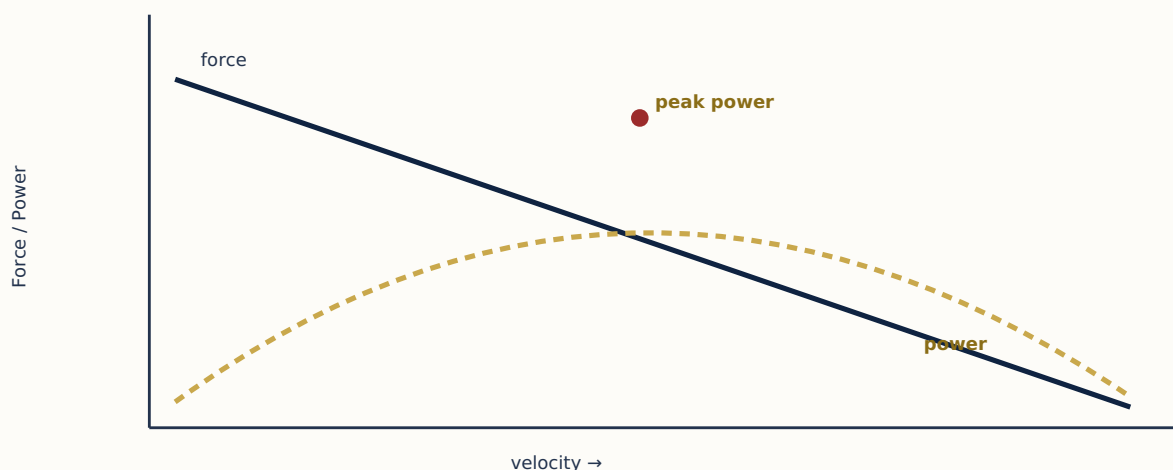
For most pulling goals, training sits deliberately on one part of the force-velocity curve: heavy and slow for maximal force, moderate and fast for power, and near-maximal velocity intent even under load to preserve RFD.

KEY IDEA

Power is force $\times$ velocity, and it peaks in the middle of the load range. Choose where on the force-velocity curve you are training, and program the load and intent to match.

Figure 18.1 · Force-velocity and power-velocity relationships

SCHEMATIC



Force falls as velocity rises; power (their product) peaks at an intermediate load.

WORKED CALCULATION · AVERAGE CONCENTRIC POWER

$$P = W / t = 510 \text{ J} / 1.2 \text{ s} \approx \mathbf{425 \text{ W}}$$

Halve the concentric time to 0.6 s at the same work and average power doubles to $\approx 850 \text{ W}$ — the mechanical basis for training pull-ups with maximal upward intent.

FIGURE 18**FIGURE 18 | Power and Rate of Force Development****KEY DECISION POINTS**

- 1 Power needs force and velocity
- 2 Fast intent must not destroy technique
- 3 Use clean reps before speed goals
- 4 Track drop-off within the set

Powerful pulling requires force production at speed without losing the path, grip or body-line standard.

Power and rate of force development.

MMSx coaching translation: "move it fast on purpose" is a power prescription. Even under load, intent to accelerate protects rate of force development.

CHAPTER 19 · PART II — PHYSICS ENGINE

Impulse and time under tension

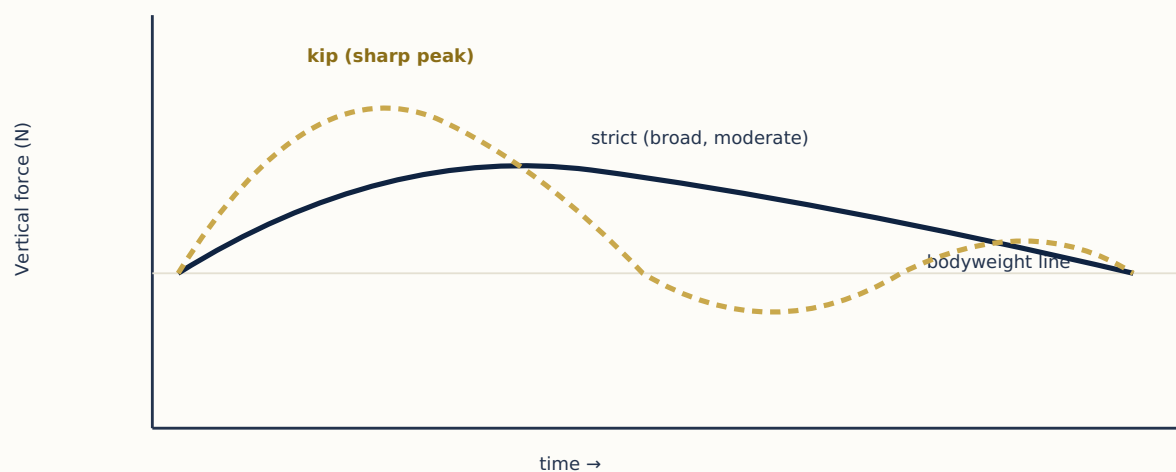
Impulse is force applied over time — the integral of force with respect to time — and it equals the change in momentum it produces (Winter, 2009). To start the body moving upward, the athlete must generate an impulse above the impulse that merely supports body weight. This is exactly what a kip does: a hip-driven surge adds impulse, transferring momentum to the body so less pure pulling force is needed at the bar. Time under tension (TUT) is a related but distinct variable — the total duration the muscles are loaded — and it is a lever for hypertrophy and tissue conditioning rather than for peak force.

KEY IDEA

Impulse moves mass; time under tension conditions tissue. A kip wins with impulse; a slow tempo wins with time. They solve different problems.

Figure 19.1 · Force-time: strict vs kipping pull (area = impulse)

SCHEMATIC



Both curves' area above the bodyweight line is the net upward impulse; the kip concentrates it into a sharp, hip-driven peak.

WORKED CALCULATION · IMPULSE TO LAUNCH THE BODY

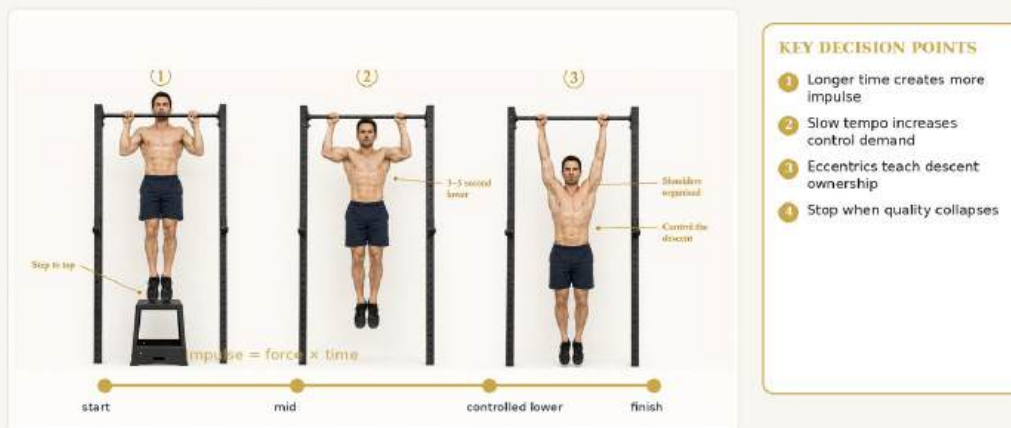
Net impulse = $m \cdot \Delta v = 80 \cdot 0.8 = \mathbf{64 \text{ N}\cdot\text{s}}$ (to reach 0.8 m/s upward)

This 64 N·s must be produced *above* the force that supports body weight — supplied by pulling in a strict rep, or partly by the hips in a kip.

CREDIBILITY & CAUTION

Kipping lowers the pulling-force requirement but raises peak shoulder loading rate. It is a valid skill, not a regression, and should be trained on a strict base (Chapter 4).

FIGURE 19

FIGURE 19 | Impulse and Time Under Tension

Impulse and time under tension explain why slow eccentrics and holds can build control before full-volume strict reps.

Impulse and time under tension.

MMSx coaching translation: if the goal is strength, buy the rep with pulling impulse; if the goal is cyclical capacity, the hips may pay part of the bill — deliberately.

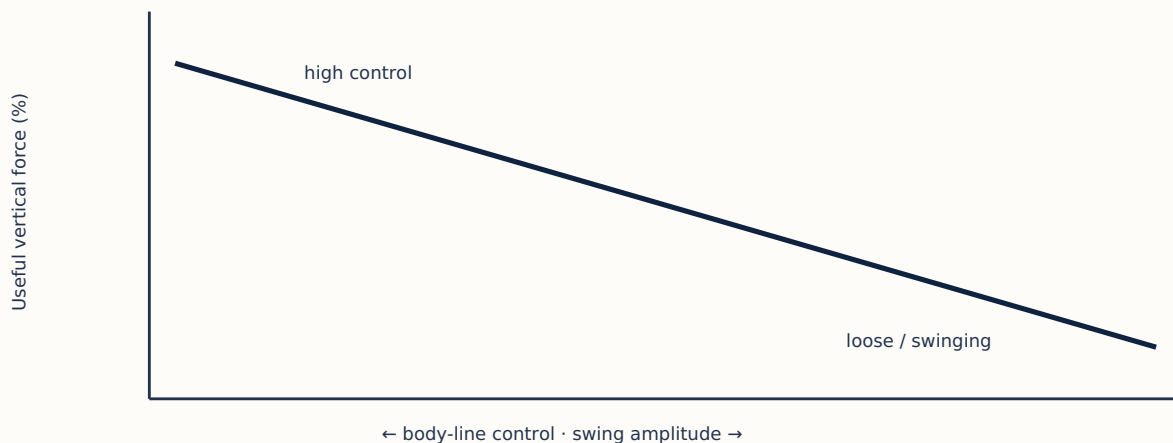
CHAPTER 20 · PART II — PHYSICS ENGINE

Centre of mass and body-line control

The centre of mass (COM) is the point through which gravity acts, and its horizontal position relative to the bar sets every moment arm in the pull. A hollow-body line keeps the COM close to a vertical path under the bar; an arched or loose line lets the COM drift forward and the body swing, lengthening the shoulder's external moment arm and bleeding pulling force into oscillation (Winter, 2009; Prinold & Bull, 2016). Body-line control is therefore not aesthetics — it is direct control of leverage and force leak.

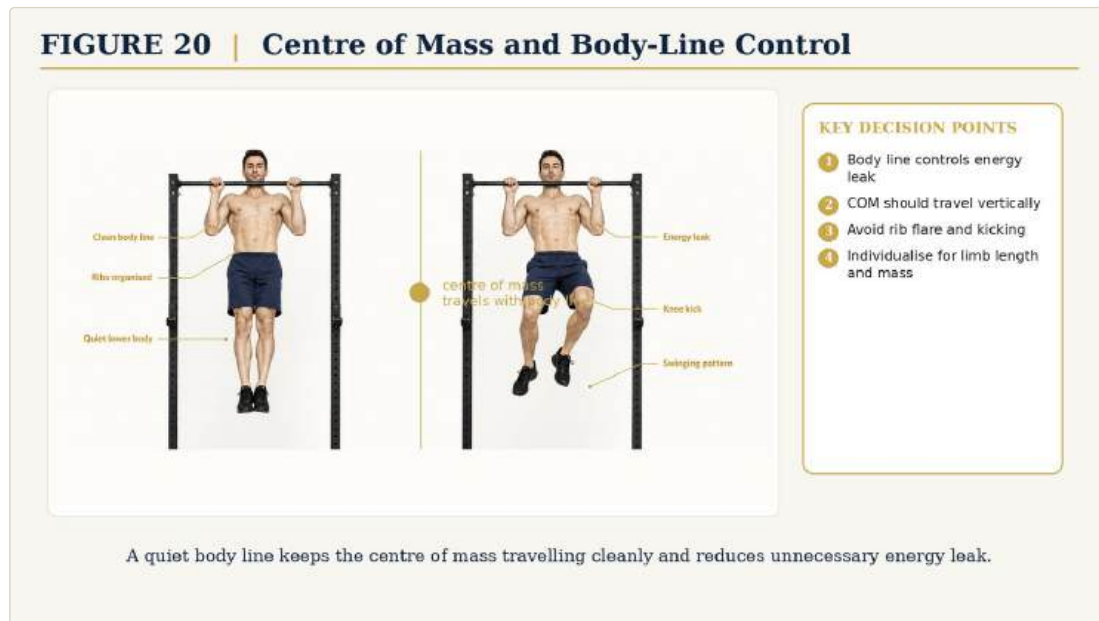
KEY IDEA

Where the COM travels decides the moment arms. A quiet, hollow line keeps the load vertical and the leverage short; a swinging line lengthens leverage and wastes force.

Figure 20.1 · Force leaked to swing vs body-line control**SCHEMATIC**

As body-line control falls and swing rises, the proportion of force expressed vertically declines.

FIGURE 20.2



Show the vertical COM path under the bar for the hollow line and the forward-drifting arc for the loose line; mark the lengthened shoulder moment arm in the swinging case.

MMSx coaching translation: "brace and stay hollow" is a leverage cue, not a style cue. It shortens the moment arm and stops the body stealing force from the pull.

CHAPTER 21 · PART II — PHYSICS ENGINE

Velocity curve and the sticking zone

Bar (or body) velocity is not constant through a pull. It rises off the hang, dips through the sticking region where torque demand peaks, and recovers toward the top. The velocity minimum marks the mechanically hardest point. Velocity-based training (VBT) uses this: mean concentric velocity is a reliable proxy for relative load, and the *velocity loss* across a set indicates accumulating neuromuscular fatigue (González-Badillo & Sánchez-Medina, 2010; Sánchez-Medina & González-Badillo, 2011; Weakley et al., 2021).

A coach can therefore stop a set at a chosen velocity-loss threshold to control fatigue, or watch the sticking dip to target the exact angle that limits the athlete.

KEY IDEA

The velocity minimum is the sticking point; the velocity loss across a set is the fatigue signal. Both are measurable decisions, not feelings.

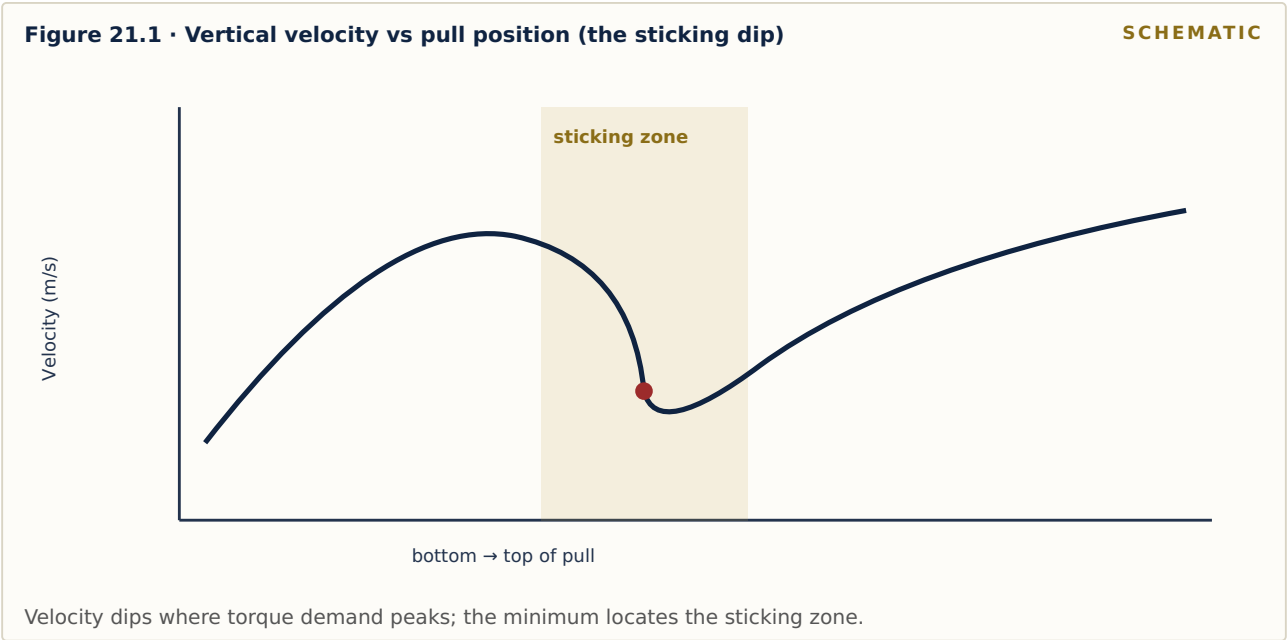
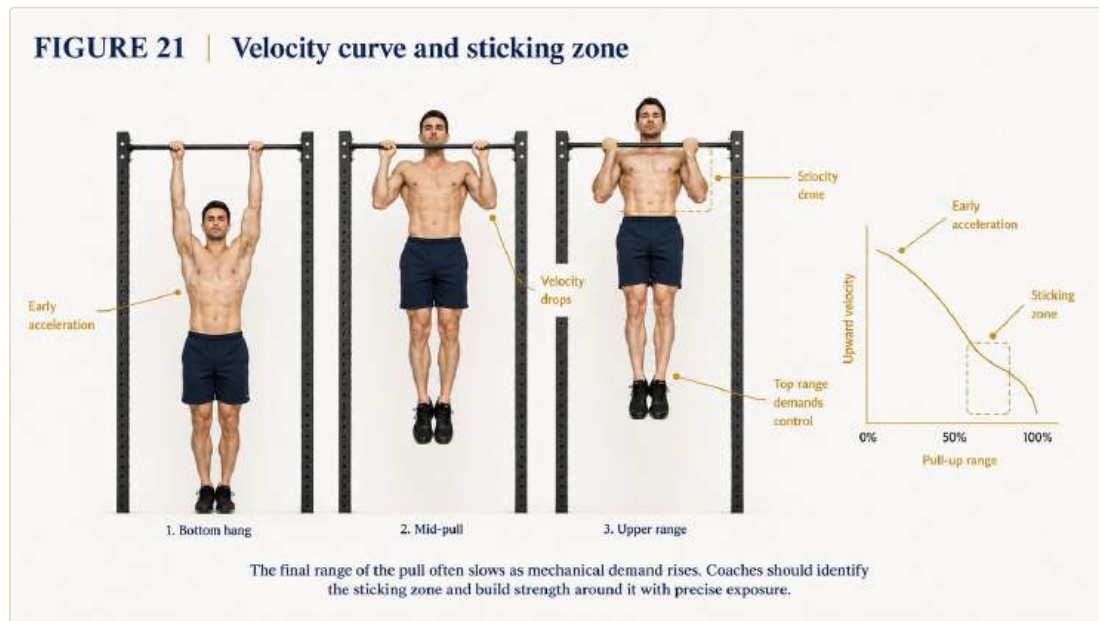


Table 21.1. Velocity-loss stop thresholds (representative use)

Velocity loss in set	Interpretation	Typical goal
~10-20%	Low fatigue; quality preserved.	Strength, power, technique.
~20-40%	Moderate fatigue accrued.	Hypertrophy with control.
>40%	High fatigue; mechanics degrade.	Rarely justified in pulling.

FIGURE 21

Velocity curve and the sticking zone.

MMSx coaching translation: stop the set when speed drops past your threshold, not when form finally breaks. Velocity loss warns you one rep earlier.

CHAPTER 22 · PART II — PHYSICS ENGINE

Band assistance and the changing load profile

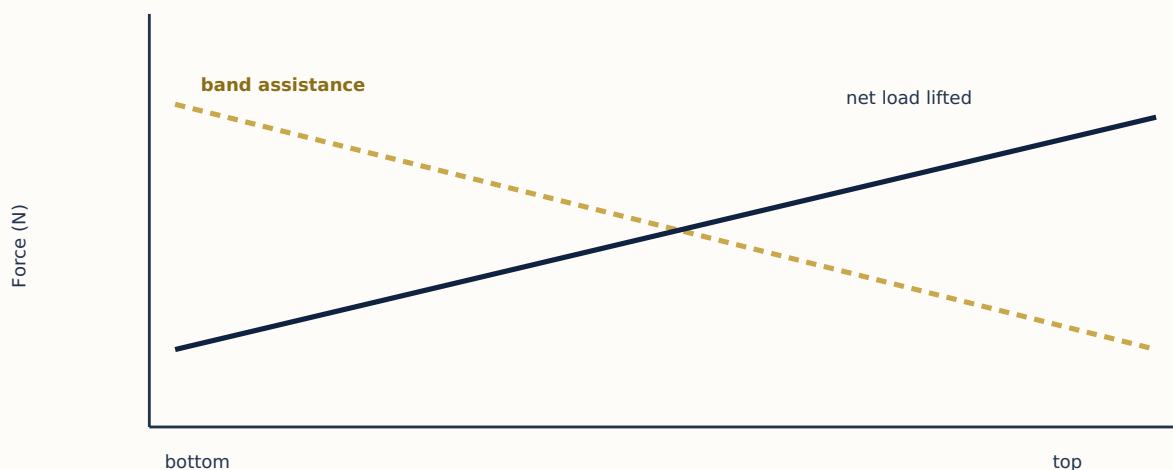
A band does not remove a fixed amount of load — it removes a *variable* amount. Elastic force is greatest where the band is most stretched (the bottom of the pull) and least near the top. Assistance therefore **descends** through the range, which means the net load the athlete lifts **ascends**: easiest at the bottom, hardest near lockout. This is the opposite profile to the natural difficulty of the pull, which is hardest in the mid-range — so a band unloads the bottom generously but leaves the top comparatively exposed (ACSM, 2009; Zatsiorsky & Kraemer, 2006).

KEY IDEA

Band assistance is biggest where you need it least (the bottom) and smallest near the top. Know the profile before you prescribe the band.

Figure 22.1 · Band assistance (descending) and net load (ascending) vs position

SCHEMATIC



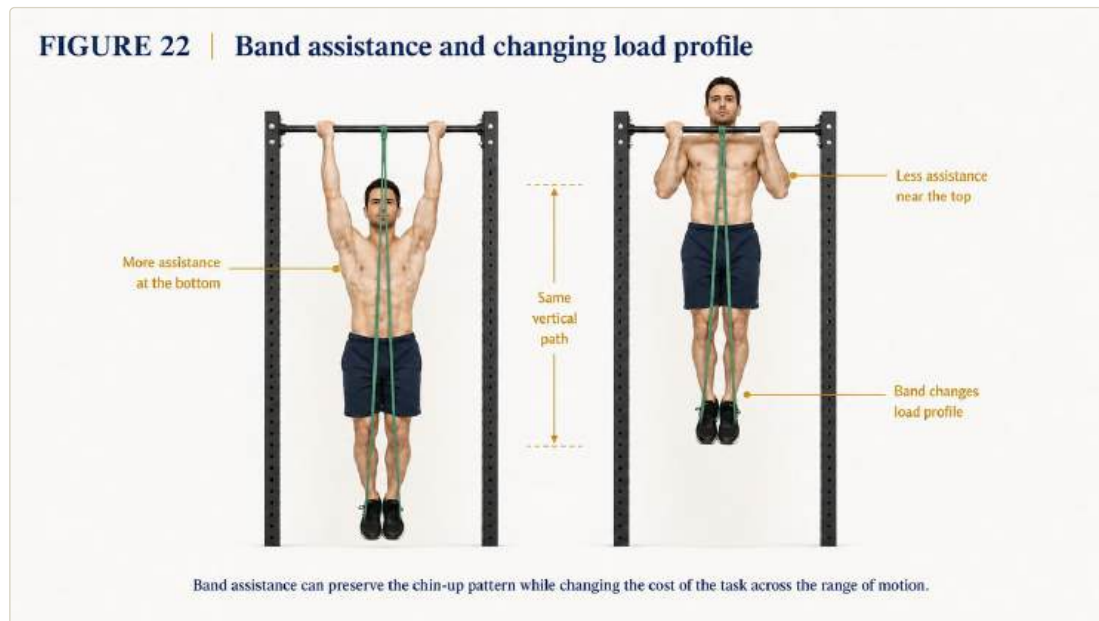
Elastic assistance falls as the band shortens; the net load the athlete must lift rises toward the top.

WORKED CALCULATION · NET LOAD WITH A BAND

Bottom: band ≈ 25 kg assist $\rightarrow$ net = $(80 - 25) \cdot 9.81 \approx \mathbf{539\text{ N}}$

Top: band ≈ 8 kg assist $\rightarrow$ net = $(80 - 8) \cdot 9.81 \approx \mathbf{706\text{ N}}$

The athlete lifts $\sim 31\%$ more at the top than at the bottom — useful for grooving the start, less so for the mid-range sticking point.

FIGURE 22

Band assistance and the changing load profile.

MMSx coaching translation: bands build the bottom of the pull. If the athlete fails in the mid-range or top, a band may not be the right assistance.

CHAPTER 23 · PART II — PHYSICS ENGINE

Machine assistance and skill specificity

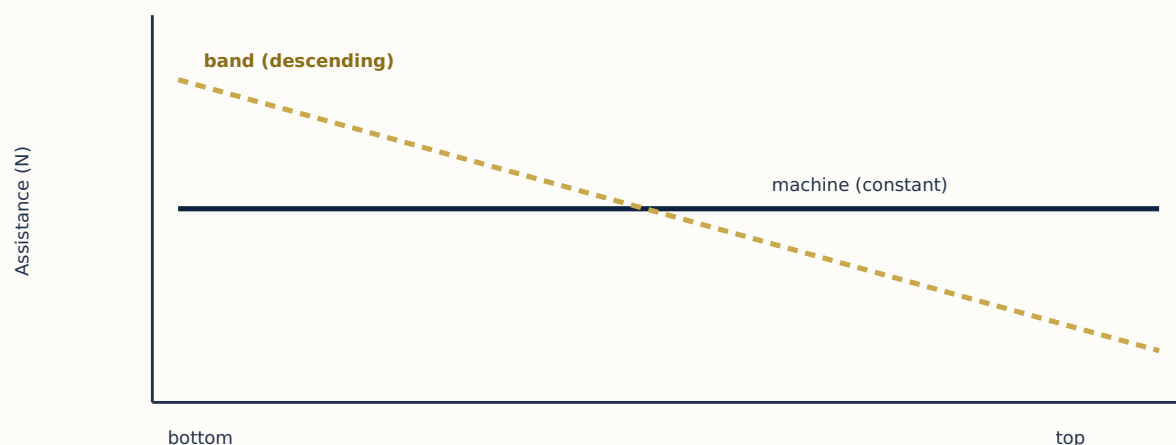
An assisted pull-up machine (counterweight or platform) supplies a *constant* assistance across the range — a flat profile, unlike the band's descending one. That makes the mid-range and top easier than a band does, which can be an advantage for an athlete who fails at the sticking point. The trade-off is skill specificity: the machine stabilises the body and removes the de-swing and grip-endurance demands, so the pattern it trains is not identical to a free pull-up neurally or mechanically (Haff & Triplett, 2016). Related pulldown work shares muscle actions but likewise differs in stability and grip demand (Signorile et al., 2002; Sperandei et al., 2009).

KEY IDEA

Machine assistance is flat and stable; band assistance is variable and free. Choose by where the athlete fails and how much transfer to the free pull-up you need.

Figure 23.1 · Assistance profile: machine (flat) vs band (descending)

SCHEMATIC



The machine unloads every part of the range equally; the band unloads the bottom most.

Table 23.1. Choosing the assistance tool

Failure point	Better tool	Reason
Bottom / start	Band	Maximal assistance exactly where it fails.
Mid-range / top	Machine (or partials)	Constant assistance holds through the sticking zone.
Grip endurance	Free hang / free reps	Machines remove the grip demand entirely.

FIGURE 23

FIGURE 23 | Machine assistance and skill specificity

Machine assistance can reduce task cost effectively, but specificity to the free-hanging pull should still be considered.

Machine assistance and skill specificity.

MMSx coaching translation: match the assistance profile to the failure point. Band for the bottom, machine or partials for the top — and free work to keep the grip honest.

CHAPTER 24 · PART II — PHYSICS ENGINE

Worked calculations for coaches

This capstone chapter assembles the quantities of Part II into one athlete profile, so a coach can see how load, torque, work, power and impulse describe the *same* rep from different angles. The archetype is **Marcus Adeyemi**, 80 kg, range of motion 0.65 m, concentric time 1.2 s, sticking-region external moment arm 0.14 m per elbow. All values are representative and reproducible with the methods cited through the part.

KEY IDEA

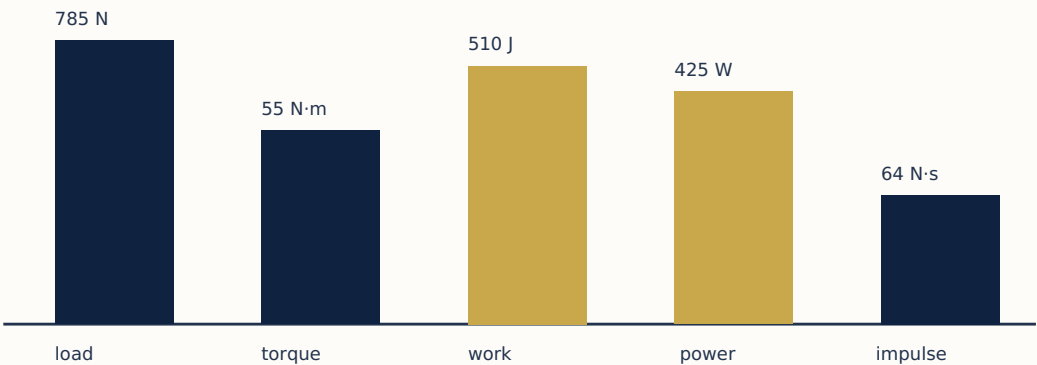
One rep, five numbers. Load, torque, work, power and impulse are complementary descriptions of the same event — together they turn "it felt hard" into something a coach can programme.

WORKED PROFILE · MARCUS ADEYEMI, ONE STRICT BODY-WEIGHT REP

- 1 · Net load: $W = 80 \cdot 9.81 = 785 \text{ N}$
- 2 · Peak elbow torque: $(785/2) \cdot 0.14 \approx 55 \text{ N}\cdot\text{m/arm}$
- 3 · Concentric work: $80 \cdot 9.81 \cdot 0.65 \approx 510 \text{ J}$
- 4 · Average power: $510 / 1.2 \approx 425 \text{ W}$
- 5 · Launch impulse (to 0.8 m/s): $80 \cdot 0.8 = 64 \text{ N}\cdot\text{s}$

Figure 24.1 · One-rep mechanical dashboard (Marcus Adeyemi)

SCHEMATIC



Bars are scaled for display only; each metric carries its own unit. A design-team dashboard replaces this schematic in the final edition.

Table 24.1. Reproduce it for your athlete

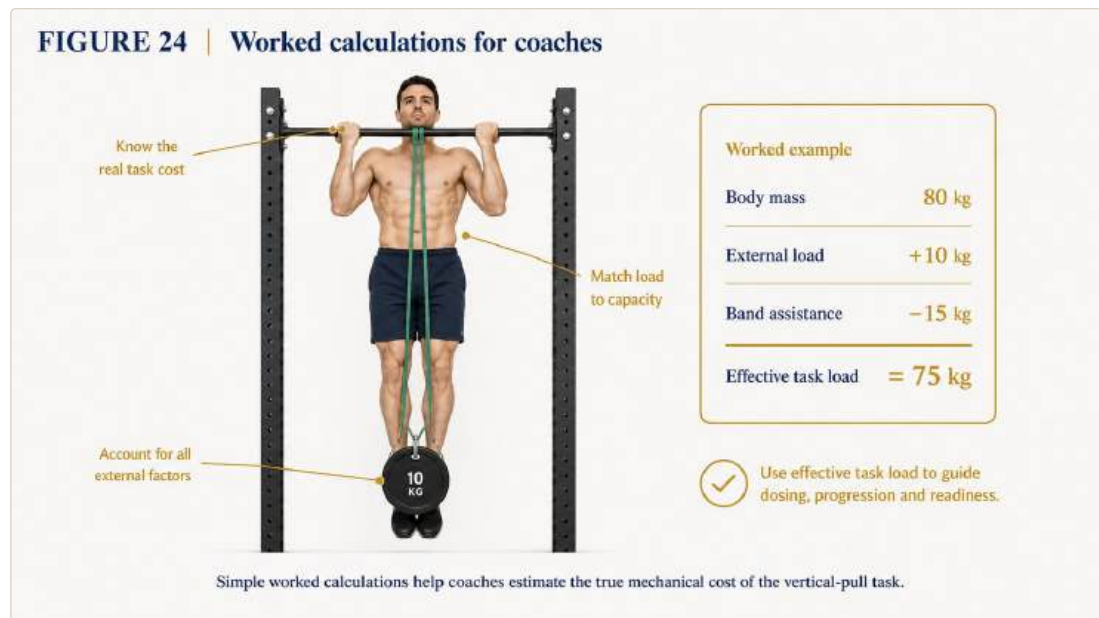
Quantity	Formula	You need
Net load	$m \cdot g$ ($\pm$ added/assist)	Body mass; any belt/band load.
Peak elbow torque	$(\text{load}/2) \cdot \text{external moment arm}$	Sticking-region moment arm estimate.
Work / rep	$m \cdot g \cdot h$	COM rise ($\approx$ range of motion).
Average power	work / concentric time	Time the concentric phase.
Launch impulse	$m \cdot \Delta v$	Target take-off velocity.

CREDIBILITY & CAUTION

These are model estimates, not laboratory measurements. They are for *relative* decisions — comparing loads, tempos and grips for one athlete over time — not for claiming an individual's true internal tissue loads.

Part III now leaves the physics engine and turns to the human machine — the joints, levers and tissues that must supply the internal torques this part has quantified.

FIGURE 24



Worked calculations for coaches.

MMSx coaching translation: keep a one-line calculation sheet per athlete. Five numbers, updated over time, turn coaching intuition into a record you can defend.

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PART III

Chapters 25 – 36

The Human Machine

Part II quantified the demands; Part III examines the machine that must meet them. Working up the chain from the hand to the pelvis, each joint is treated as a lever with a job, a tolerance and a failure mode — and the chapter closes on the anthropometry and individual variation that decide which technique fits which body.

25 • Grip interface

26 • Wrist & forearm

27 • Elbow

28 • Glenohumeral

29 • Scapula

30 • Thoracic & ribs

31 • Breathing

32 • Pelvis & legs

33 • Anthropometry

34 • Mobility

35 • Joint tour

36 • Individual variation

CHAPTER 25 · PART III — THE HUMAN MACHINE

Hand, grip and friction interface

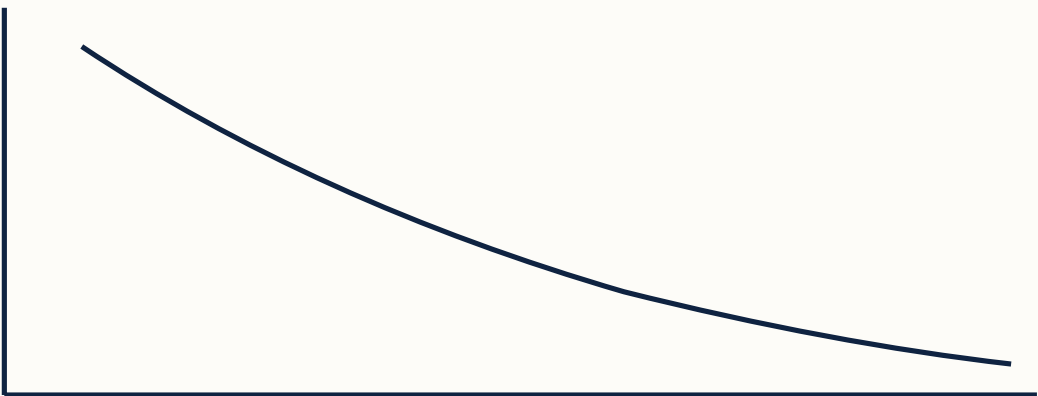
The grip is where the whole task meets the bar, and it works chiefly as a **mechanical hook**: the flexed fingers wrap the bar so the load hangs on bone and tendon, not on skin friction alone. Friction still matters — it resists the tendency of the bar to roll open the fingers and the hand to slip — and it collapses when the skin is wet, which is why sweat, not weakness, ends many sets (Seo & Armstrong, 2008). Chalk works by drying the skin and raising the effective coefficient of friction, and the hook grip reduces the active crush force the flexors must sustain.

Because the grip is the single force valve of Chapter 3, its endurance often caps performance before the prime movers fatigue. Coaching the interface — grip type, bar thickness, chalk, hand care — is therefore direct performance work, not an afterthought.

KEY IDEA

The grip is a hook backed by friction. When the hook is secure and friction is preserved, the pulling muscles decide the set; when friction fails, the grip decides it first.

Figure 25.1 · Crush force needed to resist slip vs friction (per hand, 393 N vertical) SCHEMATIC



As μ falls (e.g., sweat), the crush force needed to prevent slip rises sharply — the mechanical reason grip fails when hands are wet.

WORKED CALCULATION · GRIP FRICTION MARGIN

Vertical load per hand $\approx 785 / 2 = 393 \text{ N}$

To resist slip: $N \geq \text{load} / \mu$. Dry ($\mu \approx 0.4$): $N \approx 983 \text{ N}$; chalked ($\mu \approx 0.6$): $N \approx 655 \text{ N}$

Chalk cuts the required crush force by $\sim \frac{1}{3}$ here — often the difference between holding and slipping in the final reps. Values illustrative.

Table 25.1. Grip interface levers

Lever	Mechanical effect	Use
Chalk	Dries skin, raises effective μ .	Preserve friction late in a set.
Hook grip	Thumb locks fingers; less active crush.	Heavy or long holds.
Bar thickness	Thicker bar raises flexor demand.	Overload grip deliberately; or thin to spare it.
Straps	Bypass grip as the limiter.	When the target is the back, not the grip.

FIGURE 25.2

Show the flexed-finger hook and the friction direction resisting slip; call out chalked vs sweaty contact.

MMSx coaching translation: if the last reps slip rather than stall, the limiter is friction — chalk, hook or straps — not the back.

CHAPTER 26 · PART III — THE HUMAN MACHINE

Wrist stacking and forearm rotation

The wrist transmits everything the grip holds to the forearm, and it does so best when it is *stacked* — neither collapsed into extreme extension nor cranked into flexion. Forearm rotation (supination-pronation) sets the grip family of Chapter 5 and, with it, the line of pull of the elbow flexors; a supinated forearm places the biceps at mechanical advantage, a pronated forearm reduces it (An et al., 1981; Murray et al., 1995). Excessive wrist deviation under load is a common, avoidable source of forearm and lateral-elbow irritation.

KEY IDEA

Stack the wrist and choose the forearm rotation on purpose. Rotation selects the elbow's leverage; a stacked wrist keeps the transfer clean and the tissue quiet.



Flowchart 26.1. Wrist and forearm set-up check before loading.

Table 26.1. Wrist and forearm faults

Fault	Consequence	Correction
Collapsed extension	Load leaks; wrist strain.	Cue a stacked, slightly gripped wrist.
Over-flexed wrist	Reduced transfer; forearm cramp.	Relax to neutral; check bar thickness.
Wrong rotation for goal	Elbow leverage mismatched to intent.	Match supination/pronation to the target bias.

FIGURE 26



Contrast the stacked wrist against collapse; overlay the biceps line of pull for each forearm rotation.

MMSx coaching translation: a sore forearm or outer elbow is often a wrist-and-rotation set-up problem, not a training-volume problem.

CHAPTER 27 · PART III — THE HUMAN MACHINE

Elbow flexion mechanics

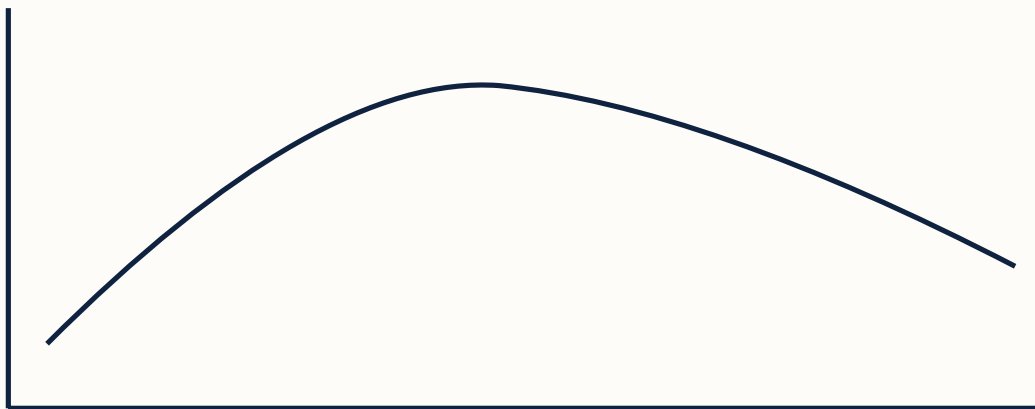
The elbow is a hinge whose flexors must supply the internal torque that answers the external demand of Chapter 16. The catch is leverage: the flexor internal moment arm is only a few centimetres and varies with angle, peaking near 90–100° of flexion for the biceps and sitting lower for the brachialis (An et al., 1981; Murray et al., 1995). Because the internal arm is short, the flexors must generate forces several times the external load — the ~4:1 penalty computed in Part II. The elbow is therefore a frequent true limiter, especially in the supinated chin-up.

KEY IDEA

The elbow is strong but poorly levered. Small internal moment arms mean large muscle forces, so the elbow fails at the mid-range where its leverage and the external demand are worst together.

Figure 27.1 · Elbow flexor internal moment arm vs flexion angle

SCHEMATIC



Representative curves after An et al. (1981) and Murray et al. (1995): biceps leverage peaks mid-range; brachialis is smaller and flatter.

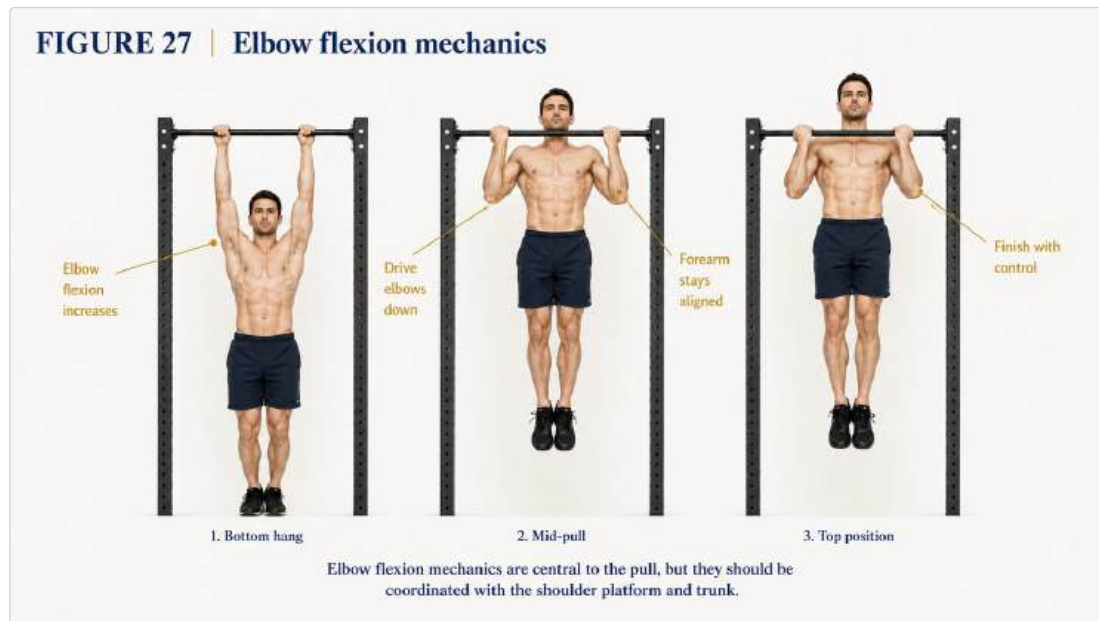
WORKED CALCULATION · REQUIRED FLEXOR FORCE

$$\tau_{\text{ext}} \approx 55 \text{ N}\cdot\text{m/arm (from Part II)} \cdot d_{\text{int}} \approx 0.035 \text{ m}$$

$$F_{\text{flexor}} = 55 / 0.035 \approx \mathbf{1\,570 \text{ N per arm}}$$

Roughly four times the external load per arm — the mechanical reason the elbow limits so many chin-ups.

FIGURE 27.2



Annotate the short internal moment arm and the resulting large flexor force.

MMSx coaching translation: if chin-ups stall mid-range, the elbow flexors are the bottleneck — train that angle directly rather than adding whole-range volume.

CHAPTER 28 · PART III — THE HUMAN MACHINE

Glenohumeral joint control

The glenohumeral joint trades stability for mobility: a large humeral head on a small glenoid, held centred by a **force couple** between the rotator cuff and the larger prime movers. In a pull, the latissimus and teres major produce powerful extension and adduction torque, while the cuff must keep the humeral head centred against that pull (Inman et al., 1944; Ludewig & Cook, 2000). Lose centration — through fatigue, a slack scapula or an uncontrolled passive hang — and the same force that should drive the pull instead drives impingement-type irritation (Ludewig & Reynolds, 2009).

KEY IDEA

Power without centration is a liability. The cuff's job is not to move the arm but to keep the head centred while the big movers do — protect that, and the shoulder tolerates heavy pulling.



Flowchart 28.1. Centration precedes power; the force couple protects the joint under load.

CREDIBILITY & CAUTION

Anterior shoulder pain, painful arc or a sense of pinching under load is a centration and referral question, not a "push through it" question. Regress range or grip and reassess; refer persistent or worsening symptoms.

FIGURE 28



Show the opposing force couple keeping the humeral head centred during the pull.

MMSx coaching translation: "set the shoulder before you pull" is a centration cue. A centred head lets the big muscles work without pinching the joint.

CHAPTER 29 · PART III — THE HUMAN MACHINE

Scapula as the hidden platform

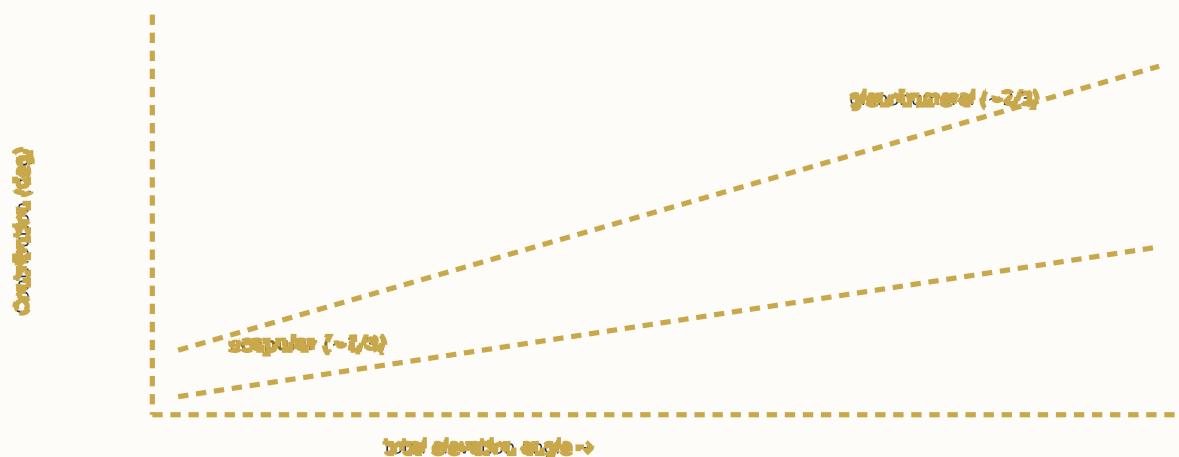
The scapula is the base the whole arm works from, and it moves in a coordinated rhythm with the humerus: across a full overhead range the humerus and scapula contribute in roughly a 2:1 ratio, though the exact split varies by phase (Inman et al., 1944; Ludewig & Reynolds, 2009). In a pull, the lower trapezius and serratus anterior must control scapular position so the humeral head has a stable platform; when this control is poor — scapular dyskinesis — force leaks and the shoulder is exposed (Kibler & Sciascia, 2010).

KEY IDEA

The scapula is the platform, not a passenger. If it is not set and controlled, every joint above it works from an unstable base.

Figure 29.1 · Scapulohumeral contribution across elevation (≈2:1 overall)

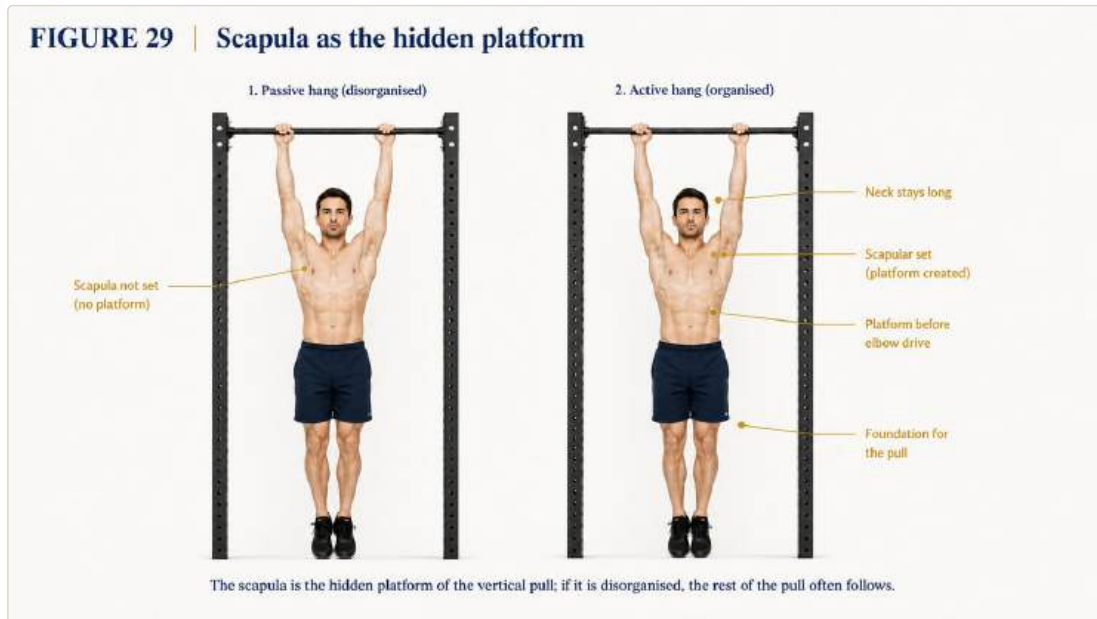
SCHEMATIC



Both segments contribute throughout range; the humerus supplies roughly twice the scapular contribution overall (Inman et al., 1944).

Table 29.1. Scapular control in the pull

Controller	Role	If under-active
Lower trapezius	Depresses and stabilises the scapula.	Scapula rides up; shoulder loses its base.
Serratus anterior	Upward rotation and rib-cage contact.	Winging; force leaks off the platform.
Mid-trapezius / rhomboids	Retraction and positional control.	Drift; inconsistent start position.

FIGURE 29.2

Contrast a depressed, controlled scapula with a winged one; mark the lost platform.

MMSx coaching translation: coach the base first. "Set the shoulder blades down" builds the platform every joint above depends on.

CHAPTER 30 · PART III — THE HUMAN MACHINE

Thoracic spine and rib cage

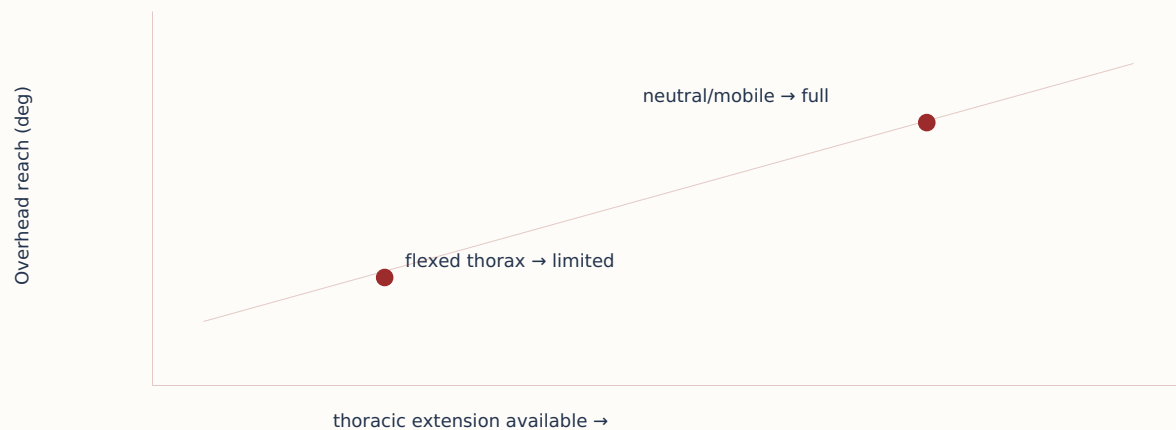
The scapula rides on the rib cage, so the shape of the thorax sets the platform's own foundation. A mobile, well-positioned thoracic spine lets the scapula rotate and sit cleanly; a rigidly flexed thorax pushes the scapula into a poor position and limits overhead reach. Rib-cage position also couples with breathing and trunk stiffness (Chapter 31): a flared, over-extended rib cage undermines the very bracing that keeps the pull quiet.

KEY IDEA

The rib cage is the floor the scapula stands on. Its position quietly decides how well the shoulder can be set — and how much overhead range is even available.

Figure 30.1 · Overhead reach available vs thoracic position

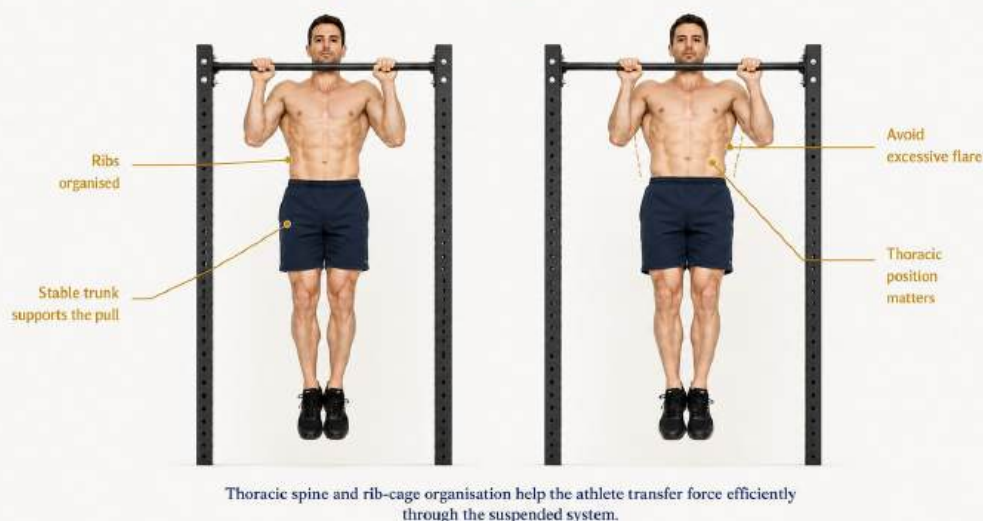
SCHEMATIC



Available overhead range rises with thoracic mobility; a flexed thorax caps it before the shoulder is the limiter.

FIGURE 30

FIGURE 30 | Thoracic spine and rib cage



Show how thoracic position changes scapular seating and available reach at the top of the pull.

MMSx coaching translation: if the top of the pull feels blocked, check the thoracic spine before blaming the shoulder — the floor may be the problem.

CHAPTER 31 · PART III — THE HUMAN MACHINE

Breathing and trunk stiffness

A quiet, powerful pull needs a stiff trunk, and trunk stiffness is built partly by breath. Intra-abdominal pressure, generated by co-contraction of the diaphragm, abdominal wall and pelvic floor, stiffens the trunk and gives the arms a stable base to pull against (Cholewicki et al., 1999; Hodges & Gandevia, 2000). A braced, controlled breath — not a held maximal Valsalva for every rep — lets the athlete keep the body line of Chapter 20 and stops the trunk from leaking force into extension and swing (McGill, 2007).

KEY IDEA

Breath is a stiffness lever. Enough intra-abdominal pressure to keep the trunk quiet lets the arms pull against something solid instead of a soft base.

Figure 31.1 · Trunk stiffness vs bracing / intra-abdominal pressure

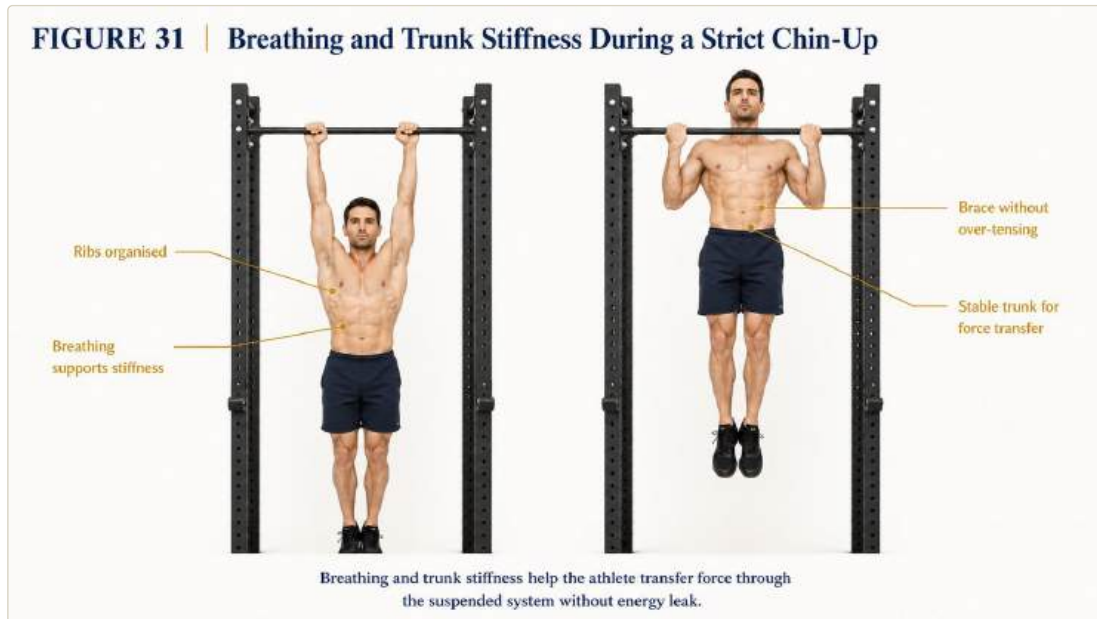
SCHEMATIC



Stiffness rises with bracing and plateaus; the aim is enough pressure to quiet the trunk, not a maximal breath-hold every rep.

CREDIBILITY & CAUTION

Repeated maximal Valsalva under load raises blood pressure sharply and is inappropriate for many populations. Match the bracing strategy to the athlete and the task; refer cardiovascular concerns.

FIGURE 31

Contrast a braced, hollow trunk with a soft, arching one; mark the brace zone.

MMSx coaching translation: "brace, then pull" gives the arms something solid to work against. A soft trunk turns pulling force into swing.

CHAPTER 32 · PART III — THE HUMAN MACHINE

Pelvis, legs and energy leak

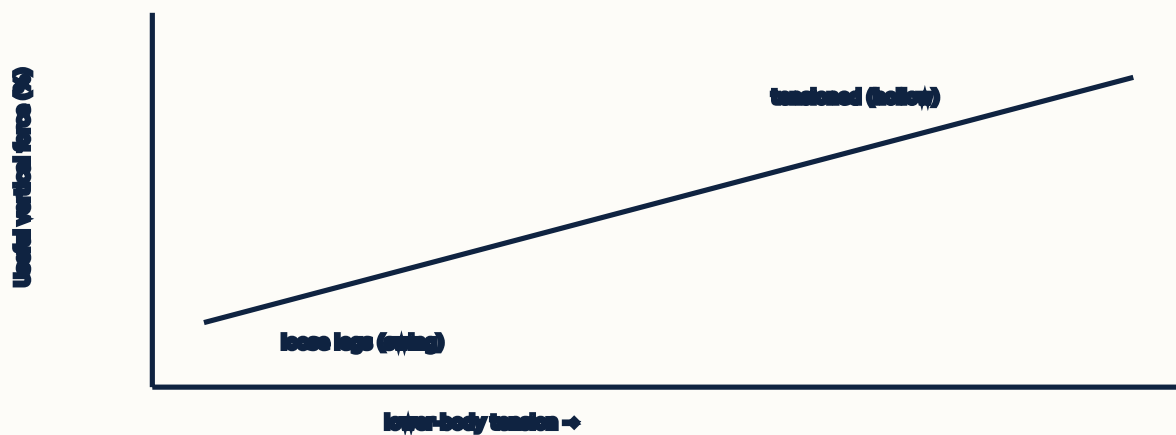
The lower body does not lift the bar, but it decides how much of the arms' work survives. A neutral pelvis and gently tensioned legs — the hollow-body position — keep the centre of mass on a vertical path and stop the body swinging (Chapter 20; Winter, 2009). Loose or kicking legs introduce a pendulum that lengthens moment arms and bleeds force into horizontal motion; deliberate leg drive, by contrast, is the basis of the kip (Chapter 19).

KEY IDEA

The legs are a switch, not an engine. Tensioned, they seal energy leaks; loose, they open a swing that steals force from the pull.

Figure 32.1 · Useful vertical force vs lower-body tension

SCHEMATIC



More lower-body tension seals the pendulum; a greater share of the arms' force is expressed vertically.

FIGURE 32

FIGURE 32 | Pelvis, legs and energy leak



Pelvis and leg organisation influence force transfer; excess movement below the trunk can leak energy and reduce control.

Show the sealed vertical path against the swinging pendulum and its leaked force.

MMSx coaching translation: "squeeze the legs and stay hollow" is an anti-leak cue. It keeps the arms' work travelling straight up.

CHAPTER 33 · PART III — THE HUMAN MACHINE

Anthropometry and the leverage tax

Two athletes of identical body mass do not face an identical pull-up. Longer limbs mean longer external moment arms and a greater range through which the centre of mass must travel, so a taller athlete pays a **leverage tax**: more torque at the joints and more work per repetition for the same body weight (Zatsiorsky & Kraemer, 2006; Winter, 2009). This is not a talent judgement — it is geometry, and it is why strict pull-up standards should be read against the individual, not a universal number.

KEY IDEA

Height and limb length are a tax on the pull. Longer levers raise both torque and work per rep at the same body mass — expect it, and programme around it.

WORKED CALCULATION · THE LEVERAGE TAX (TWO 80 KG ATHLETES)

A: forearm 0.25 m, ROM 0.65 m | B: forearm 0.29 m, ROM 0.72 m

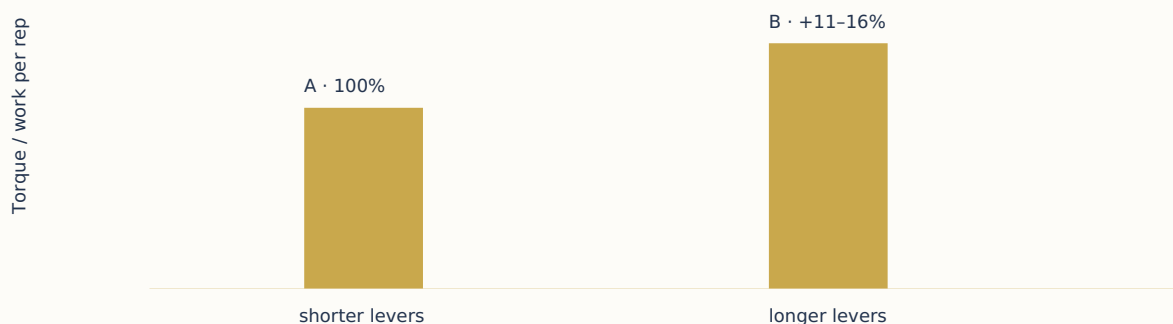
Elbow torque $\propto$ external arm: B $\approx$ +16% torque vs A at matched positions

Work/rep = $m \cdot g \cdot h$: A $\approx$ 510 J · B = $80 \cdot 9.81 \cdot 0.72 \approx$ **565 J (+11%)**

Same body weight, materially harder pull for the taller athlete. Values illustrative.

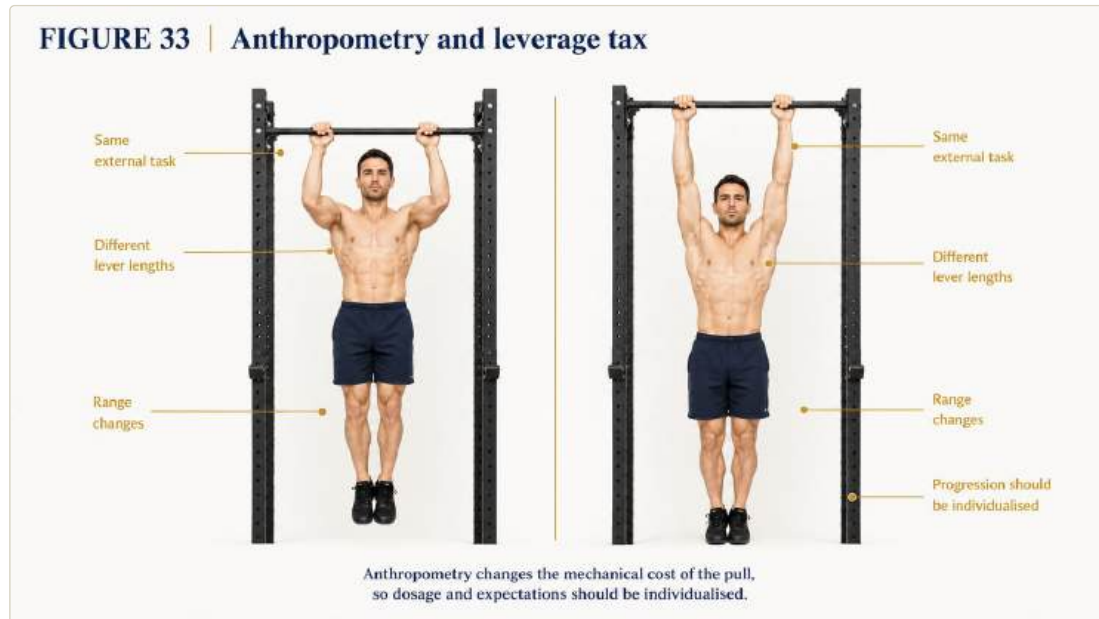
Figure 33.1 · Torque and work per rep vs limb length (illustrative)

SCHEMATIC



The taller athlete (B) faces higher torque and work per rep at equal body mass — the leverage tax made visible.

FIGURE 33.2



Overlay the differing external moment arms and ROM to show the tax.

MMSx coaching translation: don't hold a tall athlete to a short athlete's rep count. Judge progress against their own baseline; the geometry is not their fault.

CHAPTER 34 · PART III — THE HUMAN MACHINE

Mobility requirements and false restrictions

A pull-up needs enough shoulder and thoracic range to reach a clean overhead position and enough scapular control to hold it — but not unlimited mobility. Many apparent "restrictions" are not tissue shortness at all: they are motor-control problems (the athlete cannot organise the range they have), stability-driven guarding, or simple unfamiliarity. Treating a control problem as a flexibility problem wastes time and can destabilise a shoulder that needed control, not more range (Ludewig & Reynolds, 2009; Kibler & Sciascia, 2010).

KEY IDEA

Enough mobility, well controlled, beats maximal mobility. Before stretching, ask whether the restriction is tissue, control or guarding — the fix is different for each.

Restriction seen



Passive range full?



Yes → control / cue it



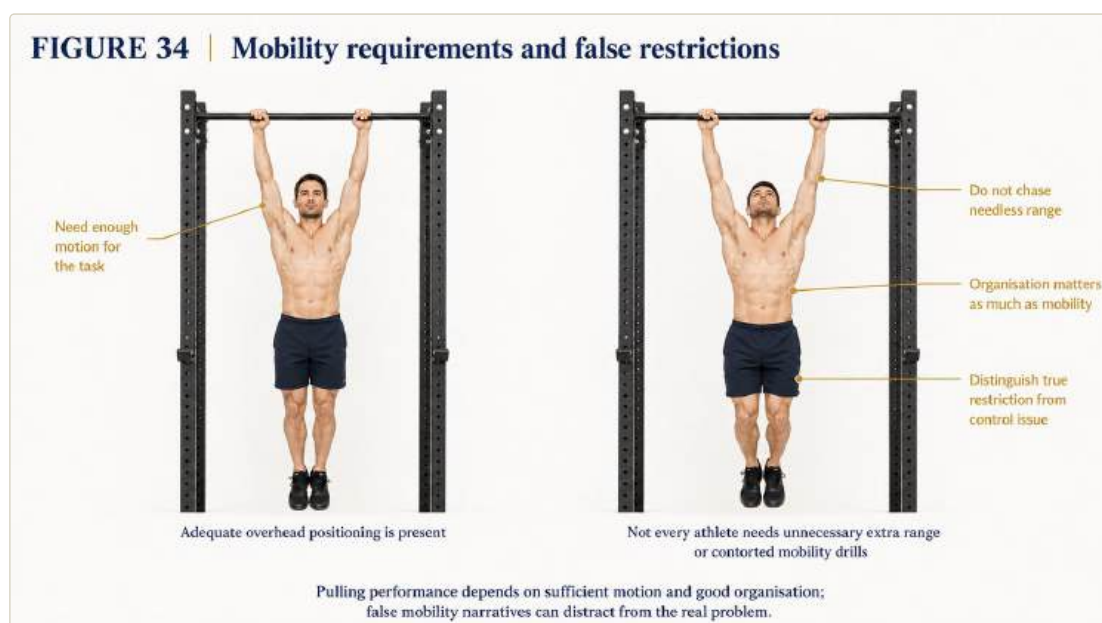
No → targeted mobility

Flowchart 34.1. Mobility triage: separate true tissue restriction from a control problem before choosing the intervention.

Table 34.1. True vs false restriction

Presentation	Likely cause	Correct response
Passive range full, active range poor	Motor control / guarding.	Coach the position; build control in range.
Passive range genuinely limited	Tissue restriction.	Targeted mobility, then re-load.
Range fine, but painful	Irritability / centration.	Regress load; reassess; refer red flags.

FIGURE 34



Illustrate the passive-vs-active gap that flags a control problem rather than a tissue restriction.

MMSx coaching translation: if the passive range is there but the pull isn't, the answer is control, not stretching.

CHAPTER 35 · PART III — THE HUMAN MACHINE

Joint-by-joint tour

The chain now assembles. Reading from the bar down, each joint has a primary job and a characteristic failure mode, and a strong pull requires every link to hold while the next does its work. This tour is the diagnostic spine of the book: when a pull breaks down, walk the chain and find the first link that yielded.

KEY IDEA

Diagnose by walking the chain. The rep is only as good as the first link that fails, so find that link before changing anything else.



Flowchart 35.1. The kinetic chain of the pull, from the bar interface to the base.

Table 35.1. The chain at a glance

Link	Primary job	Characteristic failure
Grip / hand	Hook and hold the bar.	Slip when friction fails.
Wrist / forearm	Stack and transfer load; set rotation.	Deviation strain; wrong leverage.
Elbow	Supply flexion torque.	Mid-range stall (short leverage).
Glenohumeral	Drive extension/adduction, stay centred.	Loss of centration; pinch.
Scapula	Provide the stable platform.	Winging / drift; force leak.
Trunk / pelvis	Stiffen and seal the base.	Swing; energy leak.

FIGURE 35



A single annotated figure that doubles as the book's diagnostic map.

MMSx coaching translation: when a pull fails, don't guess — walk the chain from the bar down and fix the first link that broke.

CHAPTER 36 · PART III — THE HUMAN MACHINE

Individual variation and technique selection

Because bodies differ in limb length, tissue tolerance and control, the "correct" technique is the one that fits the athlete in front of you. Anthropometry sets the leverage; symptom history sets the tolerant joints; training age sets the available control. Technique selection is the act of matching grip, range, tempo and load to those three inputs — the whole decision science of Part I, now applied to a specific machine.

KEY IDEA

There is no universal best rep — only the best rep for this body today. Match technique to leverage, tolerance and control, and re-match as they change.



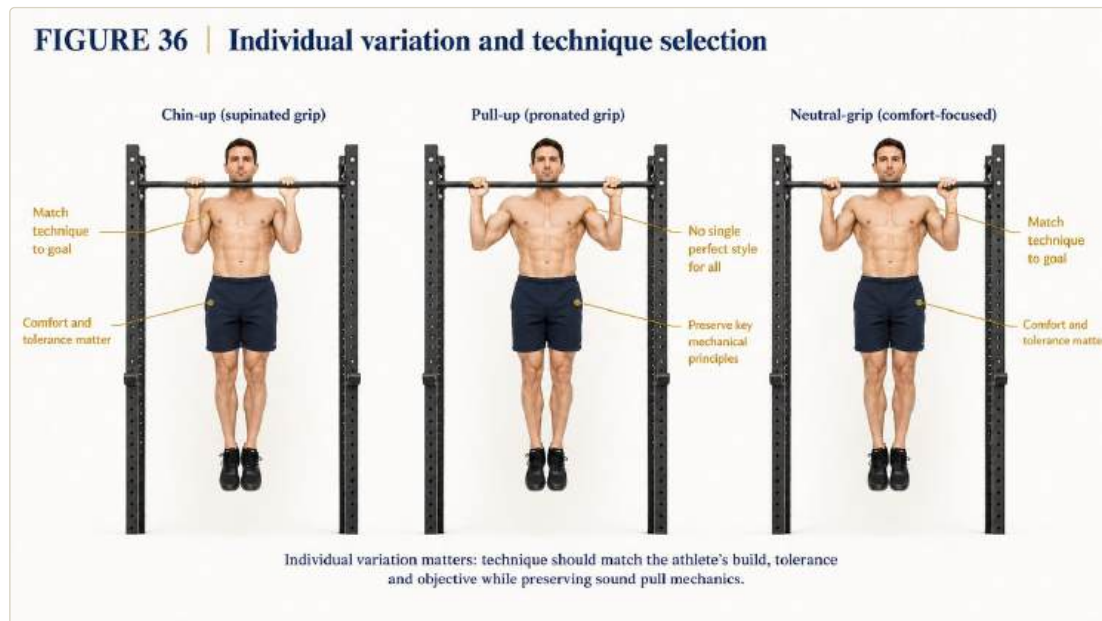
Flowchart 36.1. Technique selection as a match between three inputs and four levers.

Table 36.1. Matching technique to the individual

Input	What it tells you	Lever it sets
Anthropometry	Leverage tax; ROM and torque demand.	Range and load expectations.
Symptom history	Which joints are tolerant today.	Grip (routes peak torque).
Training age / control	How much load the pattern can hold.	Tempo and assistance.

Part IV now opens the individual muscles and tissues that supply these internal torques — the complete muscle and tissue atlas — so the levers of this part can be trained specifically.

FIGURE 36



Show the same decision science producing three different, individually correct techniques.

MMSx coaching translation: fit the rep to the body, not the body to the rep. Reassess the match whenever tolerance or control changes.

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PART IV

Chapters 37 – 48

Complete Muscle and Tissue Atlas

Part III mapped the levers; Part IV opens the engines that drive them. Each muscle is treated not as descriptive anatomy but as a torque generator — an origin, an insertion, a moment arm and a phase in which it earns its place — with the surface-EMG evidence that shows when it works hardest in the pull.

37 · Reading it

38 · Latissimus

39 · Teres major

40 · Biceps/brachialis

41 · Forearm flexors

42 · Trapezius

43 · Rhomboids

44 · Rotator cuff

45 · Serratus

46 · Pectoralis

47 · Trunk wall

48 · Phase matrix

CHAPTER 37 · PART IV — MUSCLE & TISSUE ATLAS

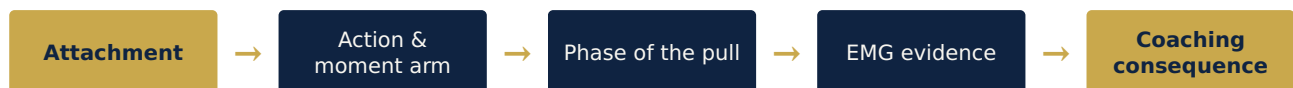
How to read the muscle atlas

Descriptive anatomy lists where a muscle attaches; a mechanical atlas asks what torque it can make, through what moment arm, and in which phase of the pull it matters. Every entry that follows is organised the same way, so a reader can move from muscle to muscle and compare their *jobs*, not just their names.

Surface EMG tells us when a muscle is active in pulling tasks, but activation is not the same as adaptation (Chapter 11): a muscle can be highly active and still not be the training target that best develops the movement. The atlas therefore pairs each muscle's mechanical role with the EMG evidence and a clear coaching consequence.

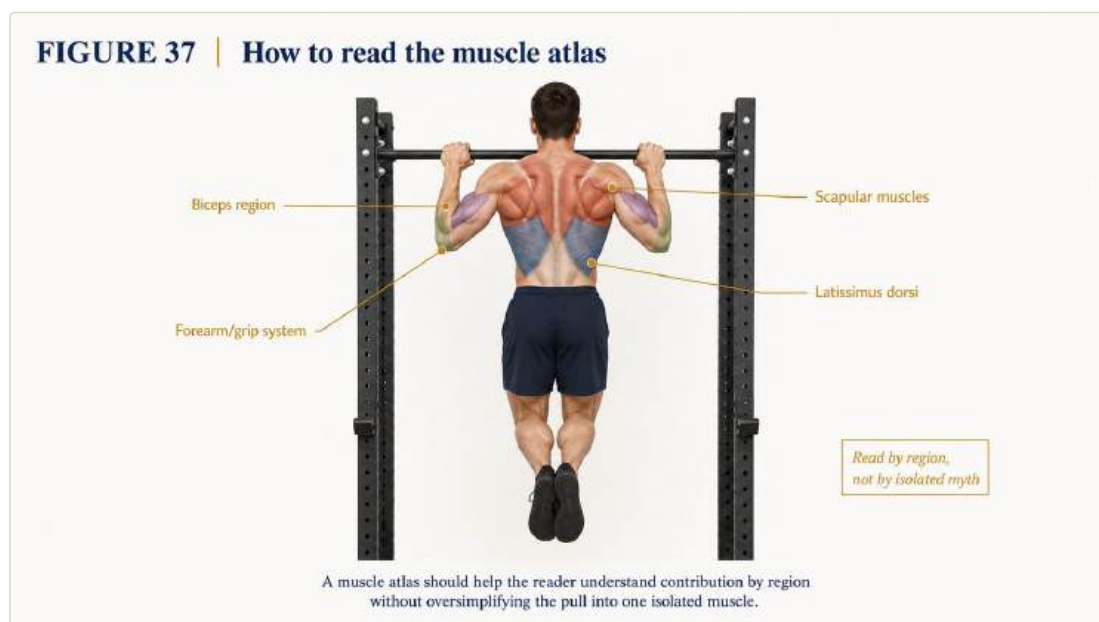
KEY IDEA

Read each muscle as a torque generator, not a diagram. Attachment sets the moment arm; the moment arm and phase set the job; EMG shows when the job is done hardest.



Flowchart 37.1. The structure of every atlas entry.

FIGURE 37



A worked example entry so readers can decode the atlas at a glance.

MMSx coaching translation: don't memorise attachments — read the job. The job tells you when to train the muscle and how to cue it.

CHAPTER 38 · PART IV — MUSCLE & TISSUE ATLAS

Latissimus dorsi

The latissimus dorsi is the prime mover of the pull: a broad muscle running from the lower spine, thoracolumbar fascia and iliac crest to the front of the humerus, so that when it shortens it drives the humerus into extension and adduction — exactly the action that raises the body to the bar. Its long span and favourable line of pull make it the main engine of vertical displacement, strongest through the initial pull and mid-range (Youdas et al., 2010; Signorile et al., 2002).

KEY IDEA

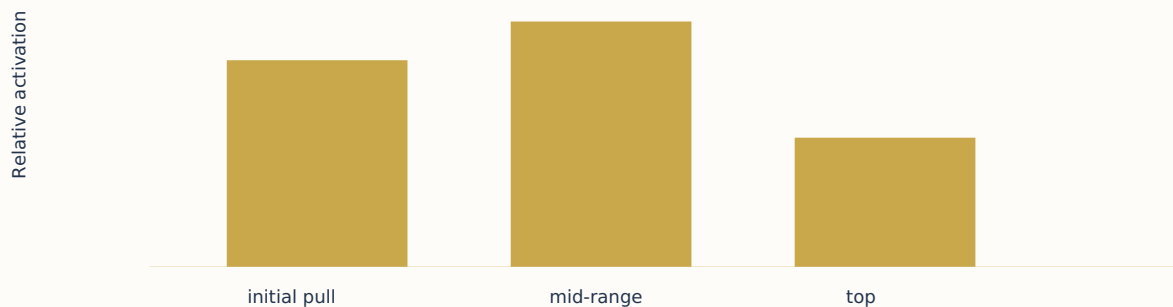
The latissimus is the engine of the pull. Grip and body line decide how much of its output reaches the bar, but the displacement is fundamentally its work.

MECHANICAL ENTRY · LATISSIMUS DORSI

Attachment	T7–L5 spinous processes, thoracolumbar fascia, iliac crest, lower ribs, inferior angle of scapula → intertubercular groove of humerus.
Action	Humeral extension, adduction, internal rotation.
Peak phase	Initial pull to mid-range.
Coaching role	Primary target for pull-up strength; pronated/wide grips emphasise it.

Figure 38.1 · Latissimus activation across the pull (illustrative)

SCHEMATIC



Highest through the initial pull and mid-range, tapering near the top. Direction consistent with pulling EMG; amplitudes illustrative.

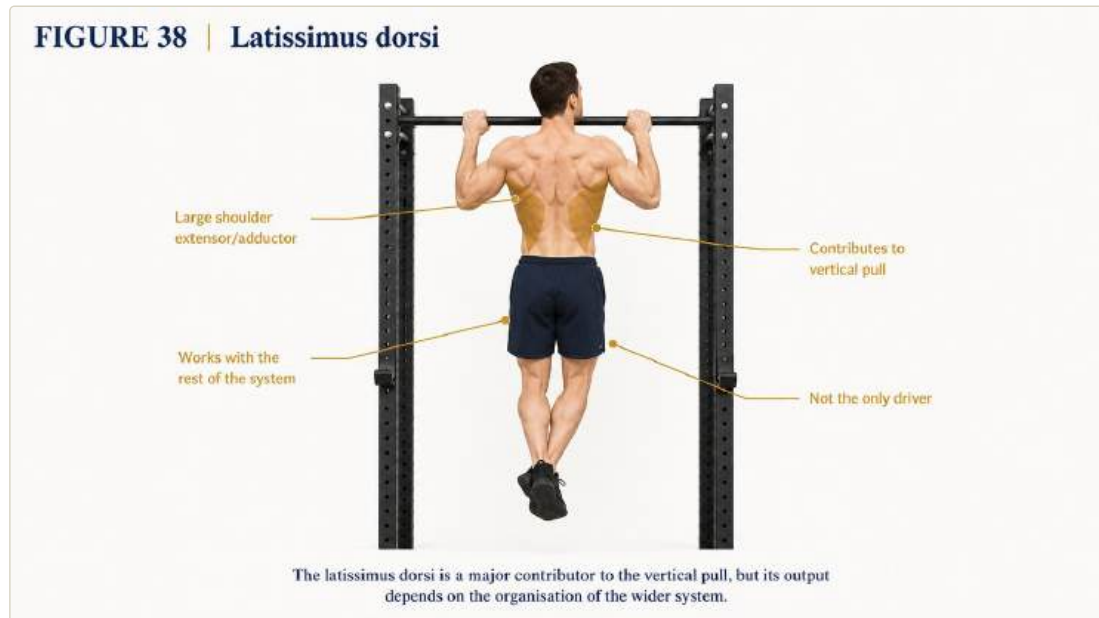
WORKED NOTE · WHY THE LATISSIMUS CAN MOVE THE BODY

Shoulder external moment arm is long; the lat's line of pull is favourable → large useful torque per unit force.

Unlike the elbow (short internal arm, ~4:1 force penalty), the shoulder's geometry lets the latissimus convert force into displacement efficiently — which is why "lead with the lats" is sound cueing for the initial pull.

EVIDENCE NOTE

Latissimus and associated back-muscle activity is high across pull-up and pulldown variants; wider pronated grips tend to raise its emphasis relative to the elbow flexors (Youdas et al., 2010; Signorile et al., 2002; Andersen et al., 2014).

FIGURE 38.2

Show the broad origin and the line of pull driving humeral extension/adduction.

MMSx coaching translation: to build the pull's engine, load full-range pronated work; to bias the elbow, switch to supinated (Chapter 40).

CHAPTER 39 · PART IV — MUSCLE & TISSUE ATLAS

Teres major and the posterior shoulder

The teres major is the latissimus's close synergist — often called "the lat's little helper" — running from the inferior angle and lateral border of the scapula to the humerus, and producing the same extension, adduction and internal rotation. Because it originates on the scapula rather than the spine, its contribution depends on the scapula being set: an unstable platform undermines it and the posterior deltoid that assists the pull.

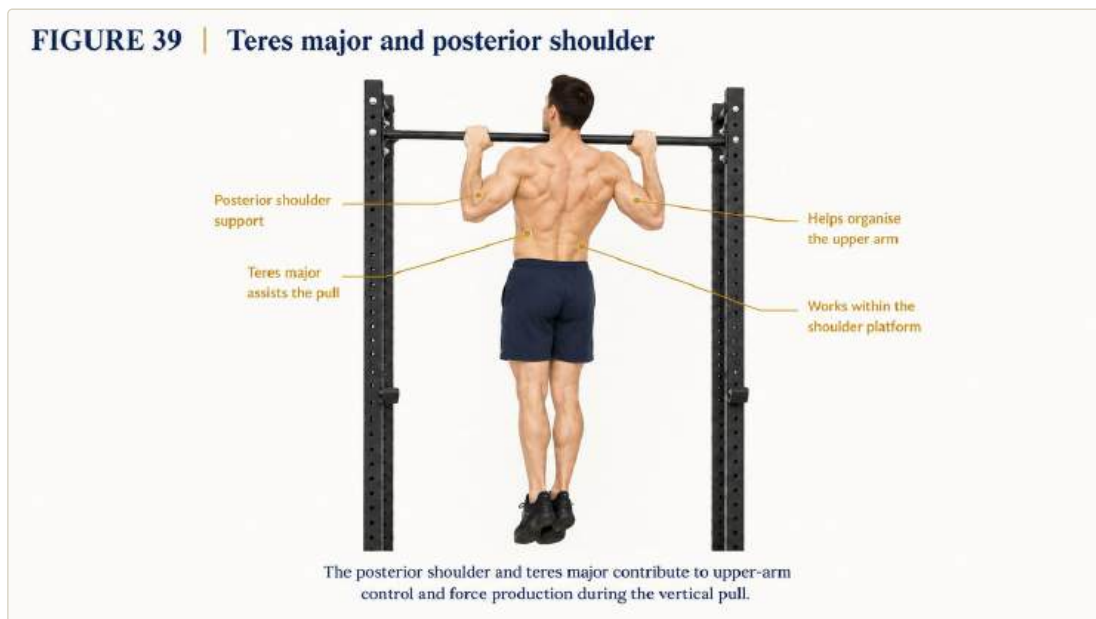
KEY IDEA

The teres major amplifies the latissimus, but only from a set scapula. Fix the platform (Chapter 29) and the posterior shoulder adds to the pull instead of leaking.

MECHANICAL ENTRY · TERES MAJOR

Attachment	Inferior angle / lateral border of scapula → medial lip of intertubercular groove.
Action	Humeral extension, adduction, internal rotation (with the latissimus).
Peak phase	Initial pull, with the latissimus.
Coaching role	Depends on scapular control; contributes when the platform is set.

FIGURE 39



Show the scapular origin and how a set platform enables the contribution.

MMSx coaching translation: the posterior shoulder helps the pull only when the scapula is anchored — coach the platform, then the helpers work.

CHAPTER 40 · PART IV — MUSCLE & TISSUE ATLAS

Biceps brachii and brachialis

The elbow flexors supply the flexion torque of Chapter 27. The biceps brachii crosses both shoulder and elbow, flexes the elbow and supinates the forearm, and is placed at strong mechanical advantage in the supinated chin-up (An et al., 1981; Murray et al., 1995; Youdas et al., 2010). The brachialis, attaching on the ulna, is a pure elbow flexor that works hard regardless of grip — the quiet workhorse of every pull.

KEY IDEA

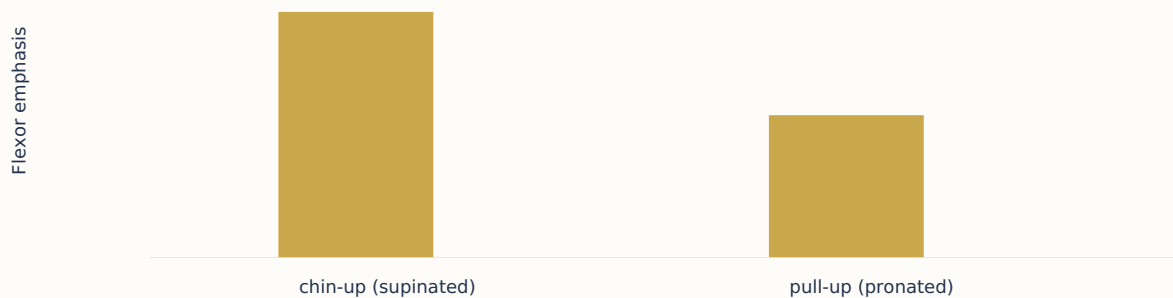
Grip decides the biceps' contribution; the brachialis pays regardless. Supinate to recruit the biceps; remember the brachialis is always working underneath.

MECHANICAL ENTRY · BICEPS BRACHII & BRACHIALIS

Biceps	Supraglenoid tubercle & coracoid → radial tuberosity. Elbow flexion + forearm supination; peak leverage ~90–100°.
Brachialis	Distal anterior humerus → ulnar tuberosity. Pure elbow flexion, grip-independent.
Peak phase	Mid-range (sticking region), especially supinated.
Coaching role	Chin-up bias; target for mid-range strength.

Figure 40.1 · Elbow-flexor emphasis by grip (illustrative)

SCHEMATIC



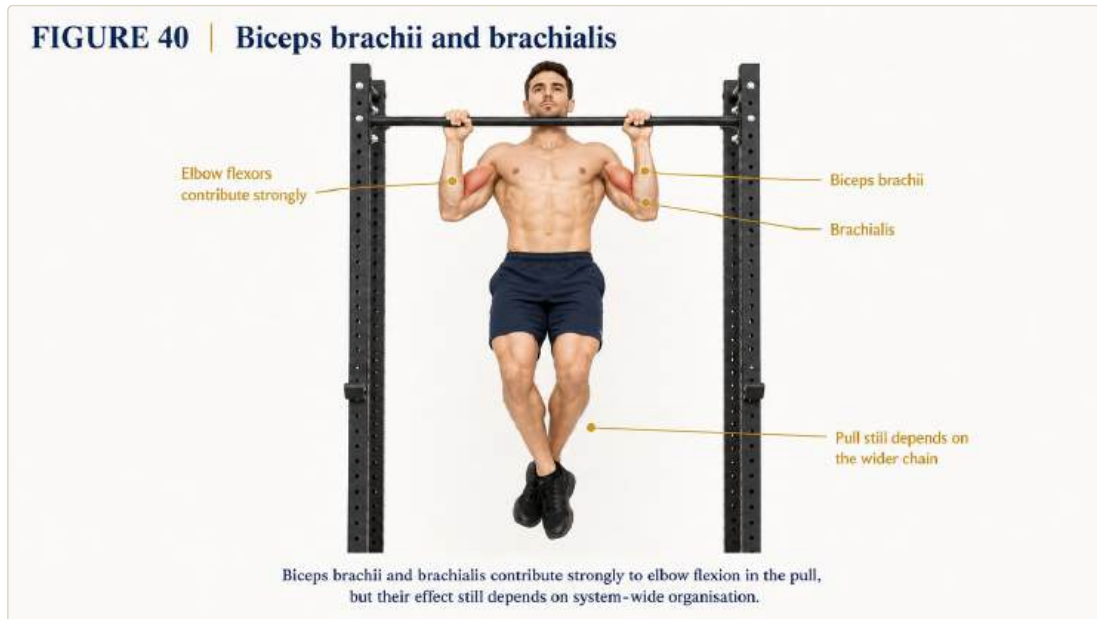
Supinated grips place the biceps at advantage, raising elbow-flexor emphasis relative to a pronated grip (Youdas et al., 2010). Illustrative.

WORKED NOTE · FLEXOR FORCE AT THE STICKING REGION

$$F_{\text{flexor}} = \tau_{\text{ext}} / d_{\text{int}} = 55 / 0.035 \approx \mathbf{1\,570\,N\,per\,arm}$$

Short internal moment arm → large muscle force. This is why chin-ups so often stall at the elbow mid-range.

FIGURE 40.2



Contrast the biceps advantage in supination with its reduced role in pronation.

MMSx coaching translation: want more arm in the pull? Supinate. Want the elbow spared? Pronate or go neutral — but the brachialis works either way.

CHAPTER 41 · PART IV — MUSCLE & TISSUE ATLAS

Brachioradialis and the forearm flexors

The brachioradialis flexes the elbow with greatest advantage in a neutral or mid-pronated forearm, and the deep forearm flexors close the grip that holds the whole task to the bar (Chapter 25). Together they are the endurance bottleneck: in long sets the forearm and grip often fatigue before the latissimus or elbow flexors, ending the set on a limiter that has nothing to do with pulling strength.

KEY IDEA

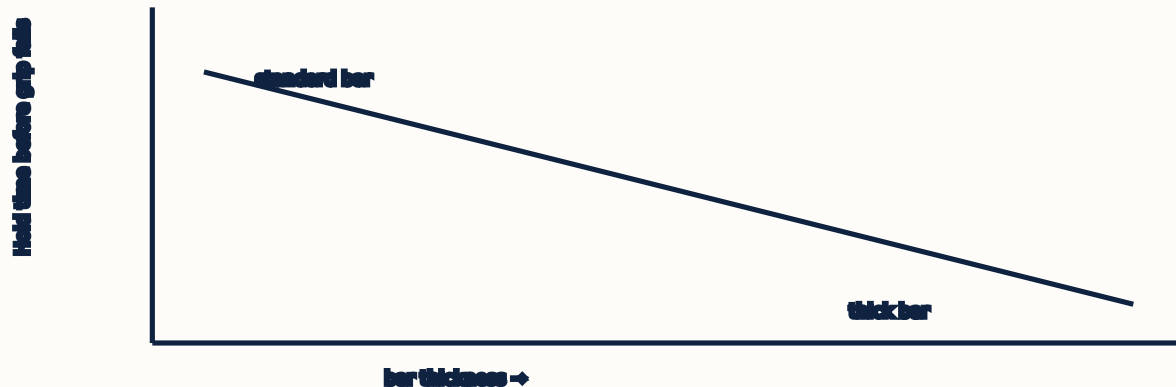
The forearm decides how long the pull lasts. Grip endurance, not pulling power, is what ends many sets.

MECHANICAL ENTRY · BRACHIORADIALIS & FOREARM FLEXORS

Brachioradialis	Lateral supracondylar ridge → radial styloid. Elbow flexion, strongest neutral/mid-pronated.
Forearm flexors	Medial epicondyle & forearm → close the fingers on the bar.
Peak phase	Sustained throughout; endurance-limited late.
Coaching role	Trainable with thick bars, hangs, holds; sparable with straps.

Figure 41.1 · Grip endurance vs bar thickness (illustrative)

SCHEMATIC



Thicker bars shorten hold time by raising flexor demand — useful to overload grip, or to avoid when the target is the back.

FIGURE 41.2**FIGURE 41 | Brachioradialis and forearm flexors**

Show the grip-closing flexors and the brachioradialis contribution in a neutral hold.

MMSx coaching translation: if sets end with open hands, train the grip directly (hangs, thick bars) — or strap it when the back is the target.

CHAPTER 42 · PART IV — MUSCLE & TISSUE ATLAS

Lower and mid trapezius

The trapezius controls the scapular platform. The lower trapezius depresses and helps upward-rotate the scapula — the action that sets the shoulder before the pull — while the mid-trapezius retracts and stabilises it. Strong, well-timed lower-trapezius activity is central to keeping the platform down and the shoulder centred through the pull (Ekstrom et al., 2003; Kibler & Sciascia, 2010).

KEY IDEA

The lower trapezius sets the platform down; the mid-trapezius holds it in. Together they make the "set the shoulders" cue physically real.

MECHANICAL ENTRY · TRAPEZIUS (LOWER & MID)

Lower trapezius	Lower thoracic spinous processes → medial spine of scapula. Depression + upward-rotation assist.
Mid-trapezius	Upper thoracic spinous processes → acromion / scapular spine. Retraction, stabilisation.
Peak phase	Set-up and initial pull.
Coaching role	Trainable with scapular pull-ups and controlled depression drills.

FIGURE 42

FIGURE 42 | Lower trapezius and mid-trapezius



The lower and mid-trapezius contribute to scapular organisation and provide a stable shoulder platform to support efficient force transfer during the vertical pull.

Show the depression and retraction that establish the platform before the elbows bend.

MMSx coaching translation: "shoulders down and set" is a lower-trap cue. Train it with scapular pull-ups so the platform holds under load.

CHAPTER 43 · PART IV — MUSCLE & TISSUE ATLAS

Rhomboids and scapular retraction control

The rhomboids run from the spine to the medial border of the scapula and retract, elevate and downwardly rotate it, working with the mid-trapezius to control scapular position. In the pull they help fix the medial border so the platform does not drift, and they contribute to the postural balance that keeps the shoulder healthy under repeated loading (Ekstrom et al., 2003).

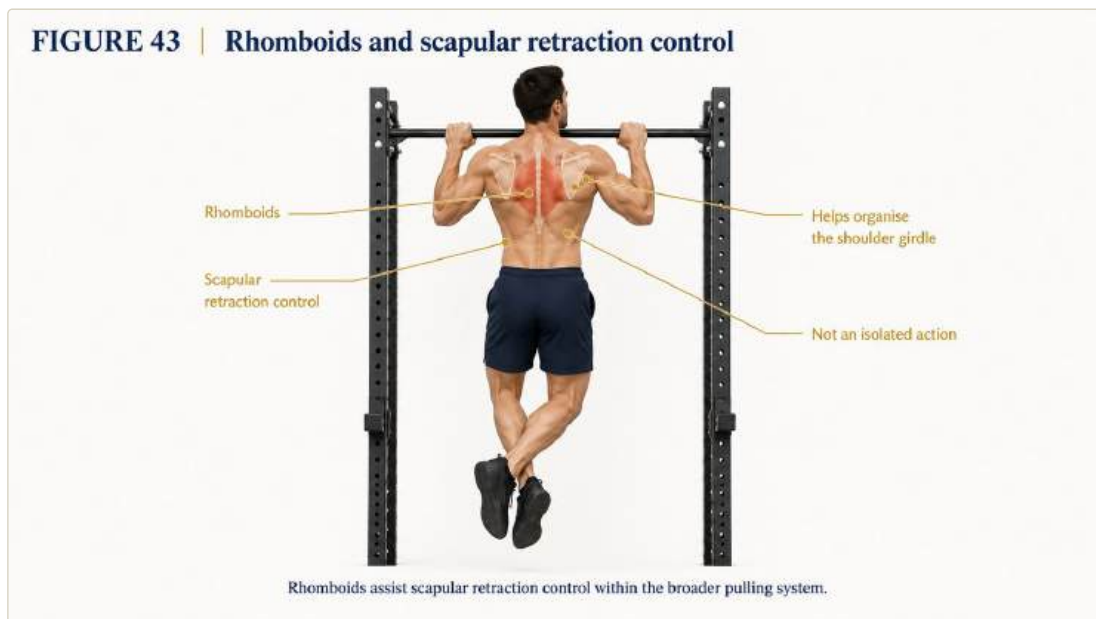
KEY IDEA

The rhomboids pin the medial border. They do not drive the pull, but without them the platform wanders and the pull loses its base.

MECHANICAL ENTRY · RHOMBOIDS

Attachment	C7–T5 spinous processes → medial border of scapula.
Action	Retraction, elevation, downward rotation; medial-border stabilisation.
Peak phase	Positional control throughout.
Coaching role	Balance with serratus/lower-trap so the scapula neither wings nor over-retracts.

FIGURE 43



Show medial-border control and what a drifting platform looks like without it.

MMSx coaching translation: if the shoulder blade slides around during the pull, the medial-border controllers need work — balance them with the serratus.

CHAPTER 44 · PART IV — MUSCLE & TISSUE ATLAS

The rotator cuff centration system

The four rotator-cuff muscles — supraspinatus, infraspinatus, teres minor and subscapularis — rarely move the bar, but they decide whether the shoulder tolerates the muscles that do. Their job is centration: keeping the humeral head seated on the glenoid while the powerful latissimus and teres major pull (Inman et al., 1944; Ludewig & Cook, 2000). Their activation is comparatively low in amplitude but high in importance — a small system guarding a large joint.

KEY IDEA

The cuff is a guardian, not an engine. Low activation, high consequence: lose its centration and the pull's own power becomes the shoulder's problem.

MECHANICAL ENTRY · ROTATOR CUFF

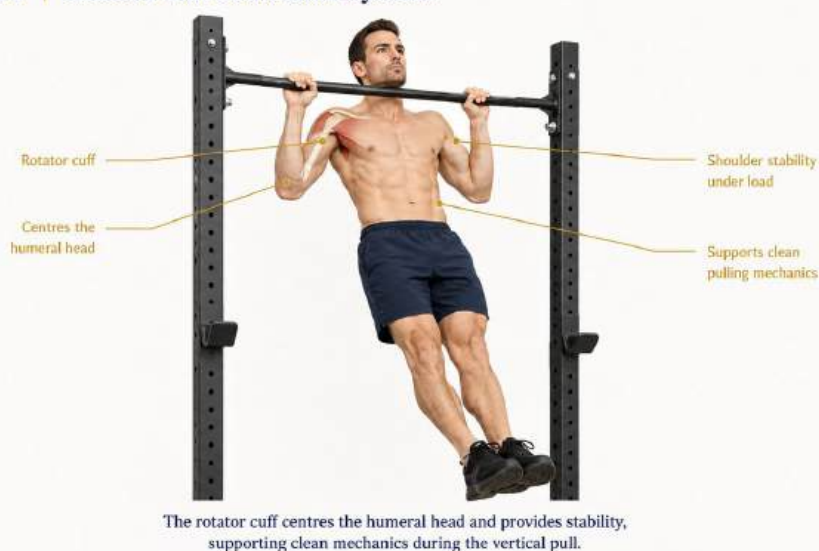
Muscles	Supraspinatus, infraspinatus, teres minor, subscapularis.
Action	Humeral-head centration; fine rotation control.
Peak phase	Throughout; critical at set-up and under fatigue.
Coaching role	Support with control and centration work; not a hypertrophy target for the pull.

CREDIBILITY & CAUTION

Painful arc, pinching or anterior shoulder pain under load is a centration and referral question. Regress range/grip and reassess; refer persistent, worsening or night-pain presentations.

FIGURE 44

FIGURE 44 | Rotator cuff centration system



Show the low-amplitude centring vectors opposing the powerful prime-mover pull.

MMSx coaching translation: you don't "feel" the cuff working, and that's the point. Protect its centration by setting the shoulder and managing fatigue.

CHAPTER 45 · PART IV — MUSCLE & TISSUE ATLAS

Serratus anterior and upward-rotation context

The serratus anterior holds the scapula flat against the rib cage and drives its upward rotation, working as a force couple with the trapezius to position the platform. When the serratus underperforms, the scapula wings off the rib cage and force leaks (Ekstrom et al., 2003; Kibler & Sciascia, 2010). In the pull it is a positioning muscle: it does not raise the body, but it decides whether the body has a stable base to be raised from.

KEY IDEA

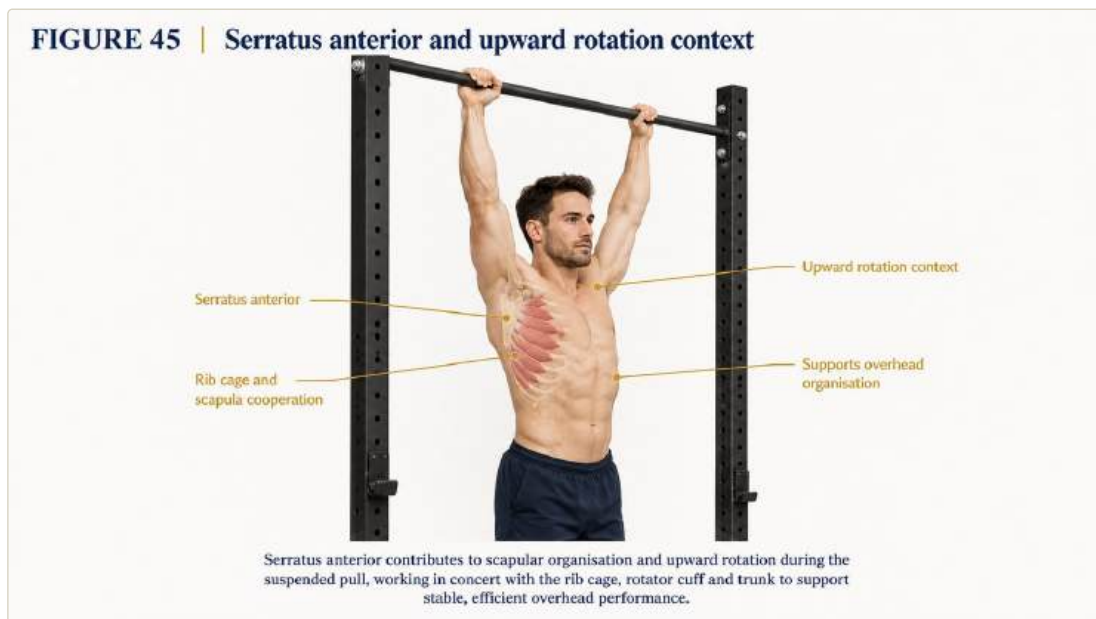
The serratus keeps the scapula on the rib cage. Winging is a serratus signal, and winging is a force leak.

MECHANICAL ENTRY · SERRATUS ANTERIOR

Attachment	Ribs 1-8/9 → medial border of scapula (costal surface).
Action	Protraction, upward rotation; holds scapula to rib cage.
Peak phase	Platform control throughout, especially overhead.
Coaching role	Anti-winging; trainable with protraction and upward-rotation drills.

FIGURE 45

FIGURE 45 | Serratus anterior and upward rotation context



Contrast a flat, controlled scapula with a winged one and the leaked force.

MMSx coaching translation: a winging shoulder blade is a serratus job. Restore rib-cage contact before adding pulling load.

CHAPTER 46 · PART IV — MUSCLE & TISSUE ATLAS

Pectoralis major and anterior-shoulder contribution

The sternal head of the pectoralis major is not only a pressing muscle: from an overhead position it assists humeral extension and adduction, adding to the pull — particularly early, when the arms are high and the pec is lengthened. Its contribution is often overlooked because the pull is filed under "back", but the anterior shoulder is a genuine, if secondary, contributor to bringing the body to the bar.

KEY IDEA

The pec helps the pull from overhead. Not the engine, but a real early contributor — another reason the pull is not "only a back exercise".

MECHANICAL ENTRY · PECTORALIS MAJOR (STERNAL HEAD)

Attachment	Sternum & costal cartilages → lateral lip of intertubercular groove.
Action	From overhead: humeral adduction & extension; internal rotation.
Peak phase	Early pull (arms high, muscle lengthened).
Coaching role	Secondary contributor; wider grips can involve it more.

FIGURE 46

FIGURE 46 | Pectoralis major and anterior shoulder contribution



Show the pec's early contribution when the arms are high.

MMSx coaching translation: the chest quietly helps the first part of the pull — one more reason a pull-up trains far more than the back.

CHAPTER 47 · PART IV — MUSCLE & TISSUE ATLAS

Trunk wall and hip-flexor control

The abdominal wall and hip flexors do not raise the body, but they decide how much of the arms' work survives. The rectus abdominis and obliques resist the extension that would arch the body and start a swing, while intra-abdominal pressure — built with the diaphragm and pelvic floor — stiffens the trunk to give the arms a solid base (Cholewicki et al., 1999; Hodges & Gandevia, 2000; McGill, 2007). The hip flexors hold the hollow-body line that keeps the centre of mass on a vertical path.

KEY IDEA

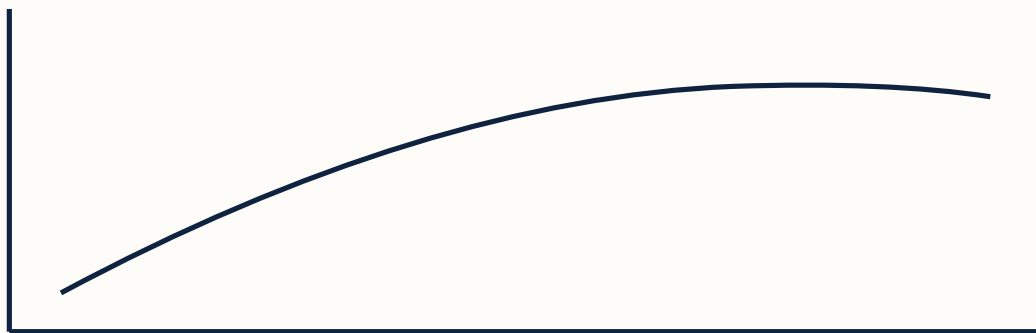
The trunk is the base, the hips hold the line. A stiff, hollow body seals the leaks that a loose trunk opens.

MECHANICAL ENTRY · TRUNK WALL & HIP FLEXORS

Abdominal wall	Rectus abdominis, obliques, transversus → anti-extension, IAP.
Hip flexors	Iliopsoas etc. → hold the hollow-body position, control leg line.
Peak phase	Throughout; anti-swing during acceleration.
Coaching role	Train with hollow holds and hanging leg-raises; brace to task.

Figure 47.1 · Trunk stiffness vs bracing / intra-abdominal pressure

SCHEMATIC



Stiffness rises with bracing and plateaus; enough to quiet the trunk, not a maximal breath-hold every rep.

FIGURE 47.2**FIGURE 47 | Trunk wall and hip flexor control**

Show the sealed hollow line against the arching leak.

MMSx coaching translation: "brace and stay hollow" is trunk-and-hip work made concrete. It keeps the arms' output travelling straight up.

CHAPTER 48 · PART IV — MUSCLE & TISSUE ATLAS

Phase-by-phase muscle matrix

The atlas now assembles into one map: which muscles work hardest in each phase of the pull. Read down a column to see what a phase demands; read across a row to see when a muscle earns its keep. The matrix is the synthesis of Part IV and the diagnostic companion to the joint-by-joint chain of Chapter 35.

KEY IDEA

Every phase has a lead actor and a supporting cast. Coach the phase where the athlete fails by training the muscles that lead it.

Figure 48.1 · Muscle activation by phase (illustrative heatmap)

SCHEMATIC

Muscle	Set-up / hang	Initial pull	Sticking (mid)	Top / finish
Latissimus dorsi	med	high	high	low
Teres major	low		med	low
Biceps / brachialis	low	med	high	med
Brachioradialis / grip	med	med	med	med
Lower / mid trapezius	high	high	med	med
Rhomboids	med	med	med	med
Rotator cuff (centrations)	med	med	med	med
Serratus anterior	med	med	med	
Pectoralis major (sternal)	med	med	low	low
Trunk wall / hip flexors	med			med

low med high Illustrative of the direction shown in pulling EMG; not raw amplitudes. Individual and grip variation apply.

EVIDENCE NOTE

The matrix synthesises pulling and pulldown EMG (Youdas et al., 2010; Signorile et al., 2002; Sperandei et al., 2009; Dickie et al., 2017) and scapular-muscle work (Ekstrom et al., 2003). Treat cells as directional hypotheses about emphasis, corroborated by the athlete's response (Chapter 11).

FIGURE 48.2



Pair each phase panel with its lead actor and supporting cast from the matrix.

Part V now leaves the atlas and enters the phase atlas and technique variables — how these muscles are actually coached through grip, range, tempo and the moment-to-moment decisions of the pull.

MMSx coaching translation: find the failing phase, read its column, and train the muscles that lead it. The matrix turns "work your back" into a targeted decision.

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PART V

Chapters 49 – 60

Phase Atlas and Technique Variables

Parts II-IV supplied the physics, the levers and the engines; Part V puts them in time. The pull is broken into six defined phases, each with its own demand and failure mode, and then the major technique variables — grip, width, tempo — are read as deliberate ways of changing which phase leads and which tissue carries it.

49 • Phase model

50 • Approach/grip

51 • Hang/set

52 • Initiation

53 • Mid-range

54 • Top finish

55 • Descent

56 • Chin-up

57 • Pull-up

58 • Neutral

59 • Width

60 • Tempo

CHAPTER 49 · PART V — PHASE ATLAS

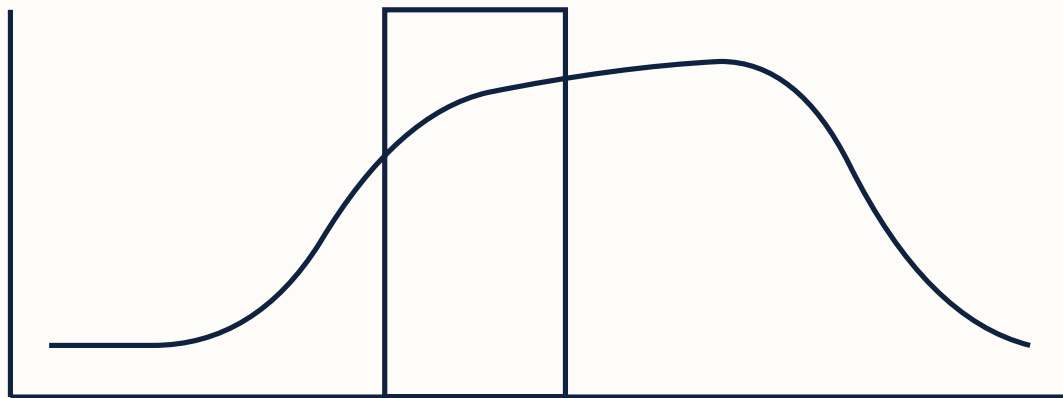
Phase model and event definitions

A pull is easier to coach when it is divided into phases with defined boundary events, because a fault can then be located in time rather than described vaguely. This reference uses a six-phase model: approach, hang and set, initiation, mid-range acceleration, top finish, and controlled descent. Each phase has an entry event, a dominant demand and a characteristic failure — the diagnostic grid the rest of Part V fills in.

KEY IDEA

Name the phase, then the fault. A fault located in a defined phase has a defined correction; a fault described as "the pull looks bad" does not.

Figure 49.1 · The six-phase timeline (body height over one repetition)

SCHEMATIC

Body height across one repetition; the shaded mid-range is the sticking region where torque demand and failure risk peak.

Table 49.1. Phase events, demands and failures

Phase	Entry event	Dominant demand	Characteristic failure
1 Approach / grip	Hands reach the bar.	Grip and set-up choice.	Wrong grip for goal/tissue.
2 Hang / set	Body hangs, scapulae set.	Scapular platform, centration.	Passive, unset shoulder.
3 Initiation	Body leaves the hang.	Impulse; latissimus/teres drive.	Swing or kip substitution.
4 Mid-range	Elbows pass ~90°.	Peak torque; sticking region.	Bar-speed collapse; stall.
5 Top finish	Chin nears the bar.	Range standard; scapular finish.	Craning; incomplete range.
6 Descent	Body begins to lower.	Eccentric control; energy return.	Uncontrolled drop.

FIGURE 49.2**FIGURE 49 | Phase model and event definitions**

Clear event definitions create consistency in coaching, analysis and repetition standards, and help the athlete understand what quality looks like at every stage of the pull-up.

A serial strip so each subsequent chapter maps to its panel.

MMSx coaching translation: teach the six phases once. From then on you can say "you failed in phase four" and both of you know exactly what to fix.

CHAPTER 50 · PART V — PHASE ATLAS

Phase 1 — approach and grip selection

The pull is decided before it begins. Approach sets hand spacing, grip orientation and the mental standard for the rep; the grip choice, as established in Chapters 5 and 16, routes peak torque toward the elbow or the shoulder and toward the athlete's tolerant tissue. A deliberate approach turns the first phase from a formality into the first coaching decision.

KEY IDEA

Grip is chosen in phase one and paid for in phase four. Select it for the goal and the tolerant joint before the hands even close.

Goal & tolerant joint?



Elbow-tolerant / arm
goal → supinated



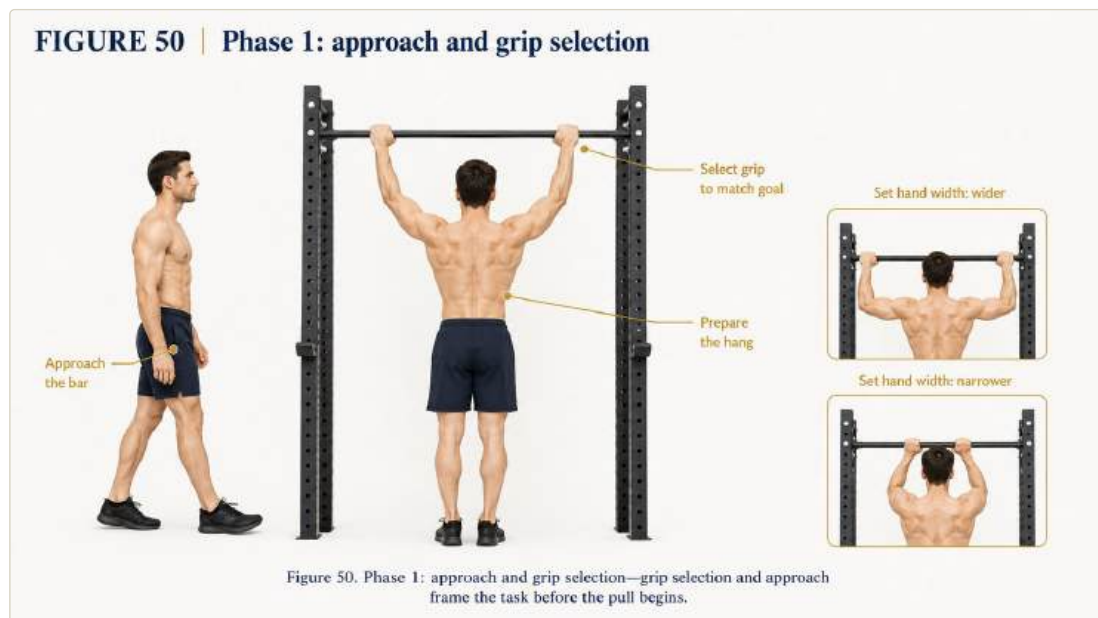
Back goal → pronated/
wide



Irritable joint → neutral

Flowchart 50.1. Grip selection at approach follows goal and tissue tolerance.

FIGURE 50



Show the set-up decisions made before the hang.

MMSx coaching translation: a good rep starts at the chalk bucket. Decide grip and standard before you jump.

CHAPTER 51 · PART V — PHASE ATLAS

Phase 2 — hang and shoulder set

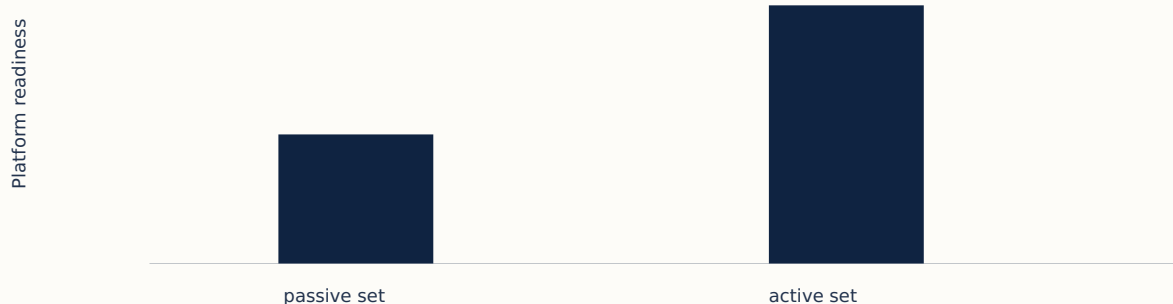
The hang is where the shoulder is prepared. An active hang sets the scapulae down and the humeral head centred, loading the pulling muscles and giving the initiation phase a stable base (Chapters 7 and 28). A passive, unset hang postpones the work and invites the shoulder to start the pull from an uncontrolled position (Ludewig & Reynolds, 2009; Prinold & Bull, 2016).

KEY IDEA

Set the shoulder before you pull. The hang is not a rest — it is the platform-building phase of the rep.

Figure 51.1 · Platform readiness: passive vs active set

SCHEMATIC



An active set delivers a far more ready platform for the pull than a passive hang. Illustrative.

FIGURE 51.2

FIGURE 51 | Phase 2: hang and shoulder set



Phase 2 establishes the organised hang: grip secured, shoulders set, trunk stacked, and the body made quiet before the pull begins.

Contrast the unset dangle with the loaded, ready active hang.

MMSx coaching translation: "pull the shoulders down before the elbows bend."
The set is the phase most athletes skip.

CHAPTER 52 · PART V — PHASE ATLAS

Phase 3 — initiation from the bottom

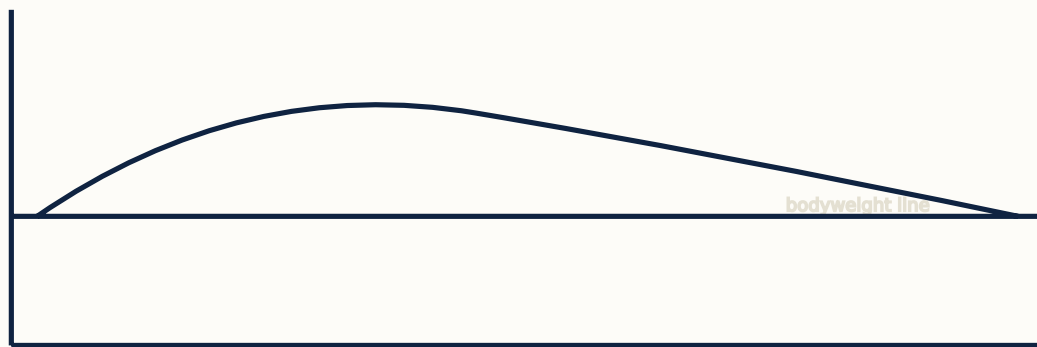
Initiation is the impulse phase: the body must be given enough upward impulse to leave the hang and reach the mid-range with momentum (Chapter 19). The latissimus and teres major lead, with the scapular depressors setting the platform; a clean initiation is a controlled surge, not a jerk or a leg-kick. This is where strict and kipping techniques first diverge — the strict rep buys the impulse with pulling force, the kip with the hips.

KEY IDEA

Initiation buys momentum. Pay for it with pulling impulse in a strict rep; do not let a swing or kick pay the bill unless that is the chosen task.

Figure 52.1 · Force-time at initiation (area above bodyweight = launch impulse)

SCHEMATIC

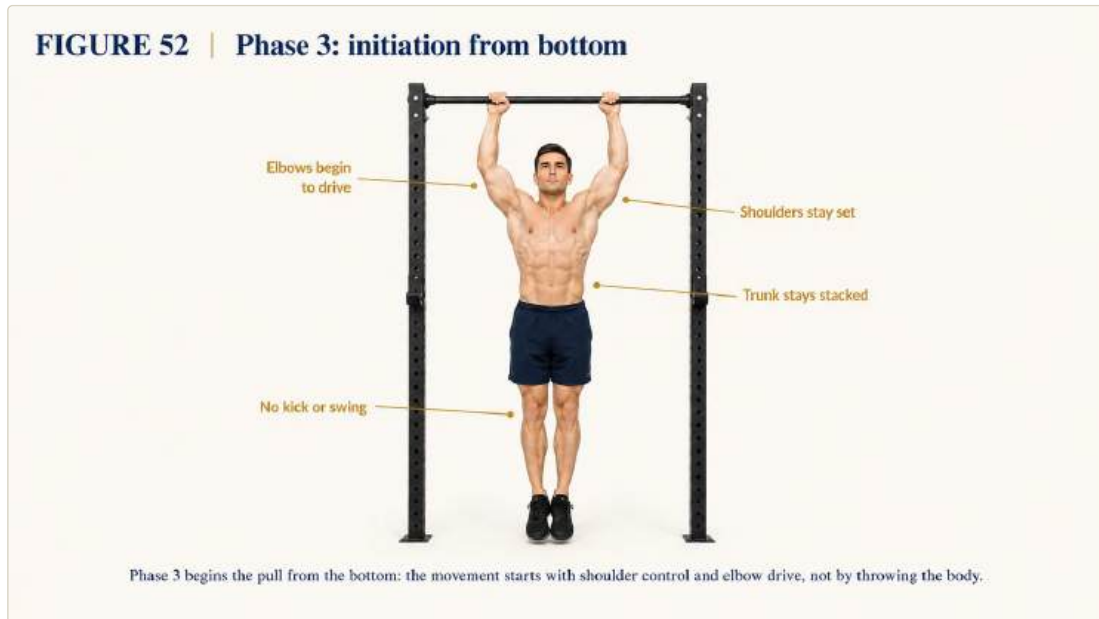


The force above the bodyweight line during initiation is the impulse that launches the body into the mid-range.

WORKED NOTE · LAUNCH IMPULSE

Net impulse = $m \cdot \Delta v = 80 \cdot 0.8 \approx 64 \text{ N}\cdot\text{s}$ to reach 0.8 m/s upward

Delivered by pulling force in a strict rep; partly by the hips in a kip (Chapter 4).

FIGURE 52.2

Show the controlled surge of a strict initiation against a hip-driven kip.

MMSx coaching translation: the first inch decides the rep. Drive the shoulders down and the elbows toward the hips — smoothly, not with a jerk.

CHAPTER 53 · PART V — PHASE ATLAS

Phase 4 — mid-range acceleration

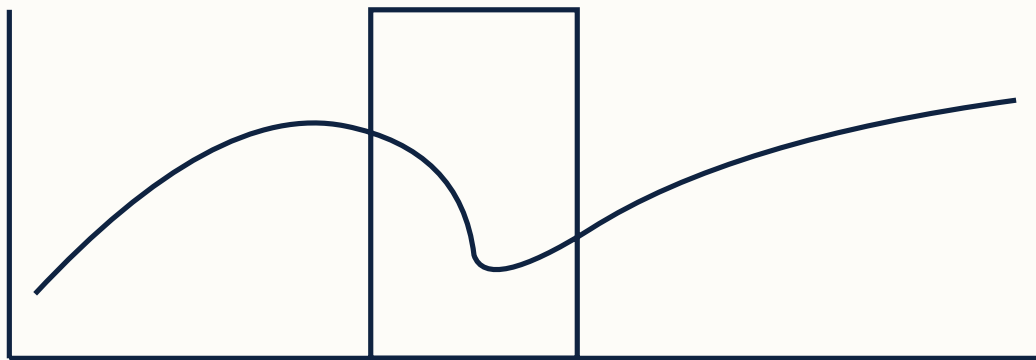
The mid-range is the crux. As the elbows pass roughly 90°, the external moment arm is longest and torque demand peaks, so bar velocity dips and most failures occur here (Chapters 16 and 21). The athlete must accelerate *through* the sticking region rather than decelerate into it; velocity-based monitoring locates this dip precisely (González-Badillo & Sánchez-Medina, 2010; Sánchez-Medina & González-Badillo, 2011).

KEY IDEA

The rep is won or lost in the mid-range. Train the athlete to accelerate through the sticking region, and regress at exactly that angle when they cannot.

Figure 53.1 · Velocity through the mid-range (the sticking dip)

SCHEMATIC



Velocity dips where torque peaks; coaching aims to raise the minimum, not merely survive it.

FIGURE 53.2

FIGURE 53 | Phase 4: mid-range acceleration



Phase 4 is the working middle of the rep: force rises through the mid-range while posture and body line stay organised.

Mark the peak-torque geometry and the drive through it.

MMSx coaching translation: "explode through the middle." If they can't, regress with partials or isometrics at that exact angle — not by making the whole rep easier.

CHAPTER 54 · PART V — PHASE ATLAS

Phase 5 — top finish and standard

The finish defines the rep. Chin-over-bar is the minimum standard; chest-to-bar is a stricter one that demands more scapular retraction and range (Chapter 6). The top is also where range honesty is most often lost, as fatigue tempts craning and half-reps. Deliberately training the top position builds range-specific strength that mid-range work does not automatically provide.

KEY IDEA

Declare the finish and hold to it. Strength at the top is range-specific; train it on purpose, and count only reps that meet the declared standard.

Table 54.1. Finish standards

Standard	Criterion	Demands
Chin over bar	Chin clearly above the bar.	Minimum counted standard.
Chest to bar	Sternum reaches bar height.	More retraction and range.
Paused top	Brief hold at the top.	Top-range isometric strength.

FIGURE 54



Contrast honest finishes with the craning fault fatigue produces.

MMSx coaching translation: pick the finish standard up front. When the chin stops clearing cleanly, the set is over — don't crane to fake it.

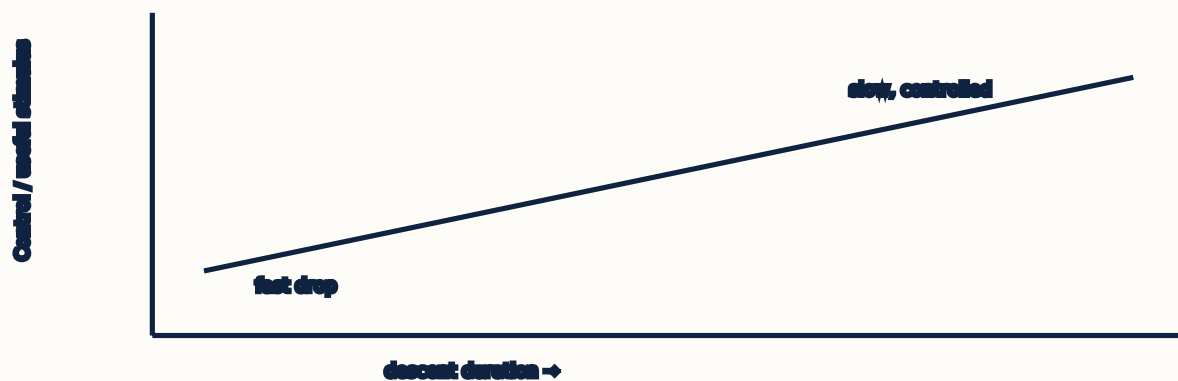
CHAPTER 55 · PART V — PHASE ATLAS

Phase 6 — controlled descent

The descent is not a free ride. The eccentric phase returns the energy stored by lifting the centre of mass (Chapter 17) and is a potent stimulus when controlled — but a dropped, uncontrolled descent wastes it and loads the shoulder and elbow abruptly at the bottom. Tempo on the descent is a deliberate lever: slower eccentrics raise time under tension and control; a dropped bottom raises injury risk for no benefit.

KEY IDEA

Own the descent. A controlled eccentric is free training stimulus; a dropped one is a discarded rep and an unnecessary risk.

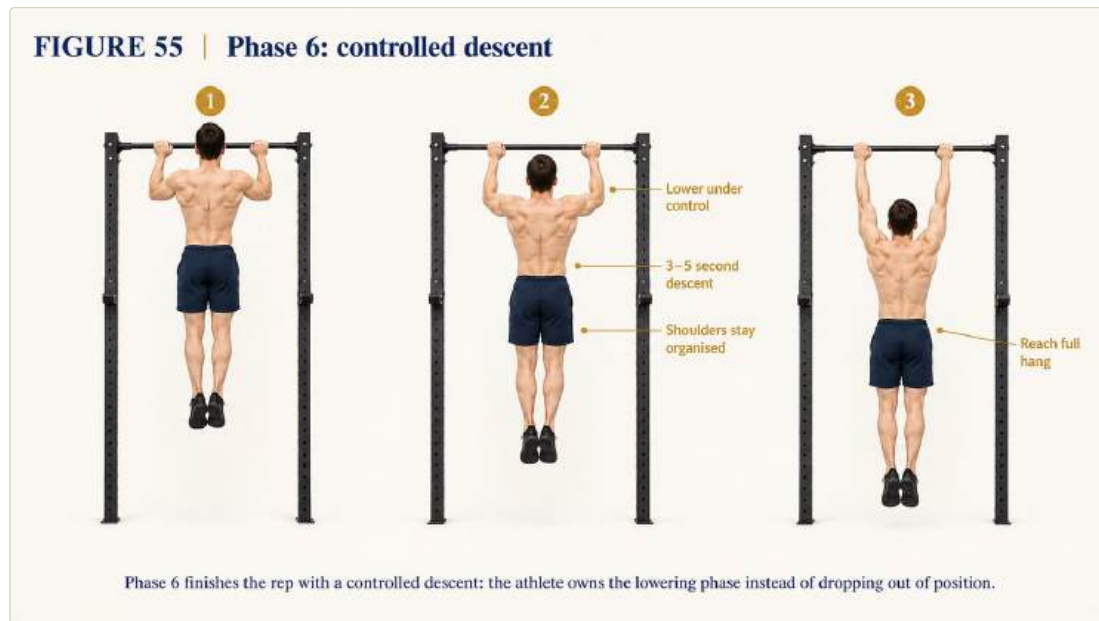
Figure 55.1 · Eccentric control vs descent tempo**SCHEMATIC**

Slowing the descent raises control and eccentric stimulus; a fast drop discards both.

CREDIBILITY & CAUTION

A dropped bottom loads the shoulder and elbow abruptly at end-range. For irritable joints, control the last third of the descent especially, and avoid ballistic bottoming out.

FIGURE 55.2



Show the controlled return against the ballistic drop.

MMSx coaching translation: "lower like it matters." The descent is half the rep and most of the free stimulus.

CHAPTER 56 · PART V — TECHNIQUE VARIABLES

Supinated chin-up

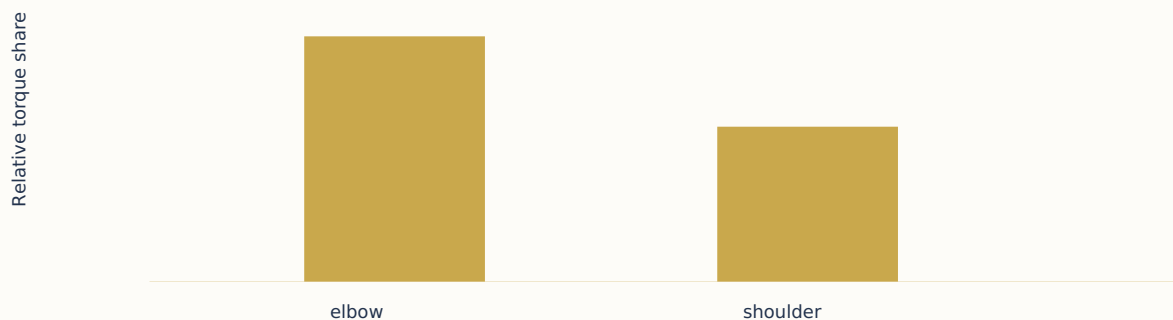
The supinated chin-up places the forearm in supination, giving the biceps strong mechanical advantage and biasing the pull toward the elbow flexors (Chapters 5, 27 and 40). It is often the strongest grip for a given athlete and a good choice when the goal is arm and pulling strength or when the shoulder prefers the supinated position — but it concentrates demand on the elbow, which becomes the likely limiter (Youdas et al., 2010).

KEY IDEA

The chin-up is the elbow-flexor variant. Strongest for many, but it routes the peak to the elbow — plan for that joint to be the limiter.

Figure 56.1 · Torque distribution — chin-up (illustrative)

SCHEMATIC



The chin-up shifts a larger share of the demand to the elbow flexors.

FIGURE 56.2

FIGURE 56 | Supinated chin-up



The supinated chin-up changes forearm orientation and often increases biceps demand while preserving the vertical-pull task.

Show the supinated set-up and the elbow-flexor bias.

MMSx coaching translation: chin-ups for arm and pulling strength — but if elbows flare up, this is the grip to rotate away from first.

CHAPTER 57 · PART V — TECHNIQUE VARIABLES

Pronated pull-up

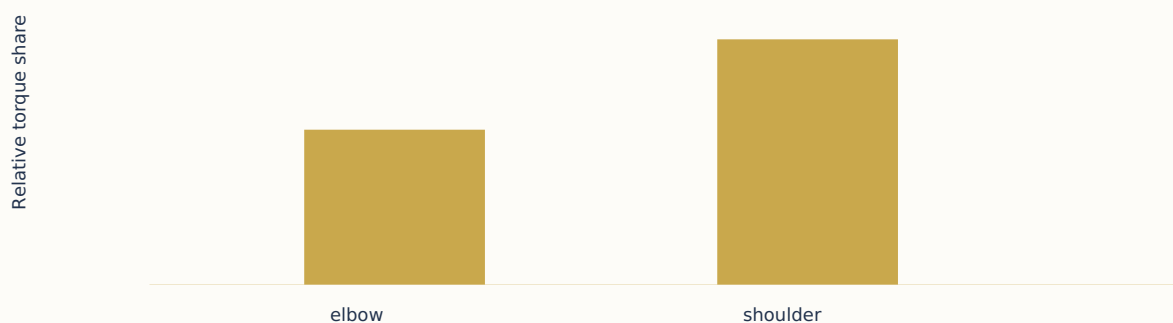
The pronated pull-up reduces the biceps' advantage and shifts emphasis toward the latissimus and the scapular controllers, especially at wider widths (Chapters 5 and 38; Signorile et al., 2002; Andersen et al., 2014). It is typically harder than the chin-up for the same athlete and is the classic choice for back-dominant strength and sport carry-over, at the cost of a longer shoulder moment arm to manage.

KEY IDEA

The pull-up is the back-and-scapula variant. Harder for most, it emphasises the latissimus and demands more scapular control.

Figure 57.1 · Torque distribution — pull-up (illustrative)

SCHEMATIC



The pull-up shifts a larger share of the demand to the shoulder and scapular system.

FIGURE 57.2

FIGURE 57 | Pronated pull-up



The pronated pull-up keeps the same vertical-pull problem while shifting forearm position and comfort profile.

Show the pronated set-up and the back/scapular bias.

MMSx coaching translation: pull-ups for back strength and carry-over — but coach the scapular set hard, because this grip exposes it.

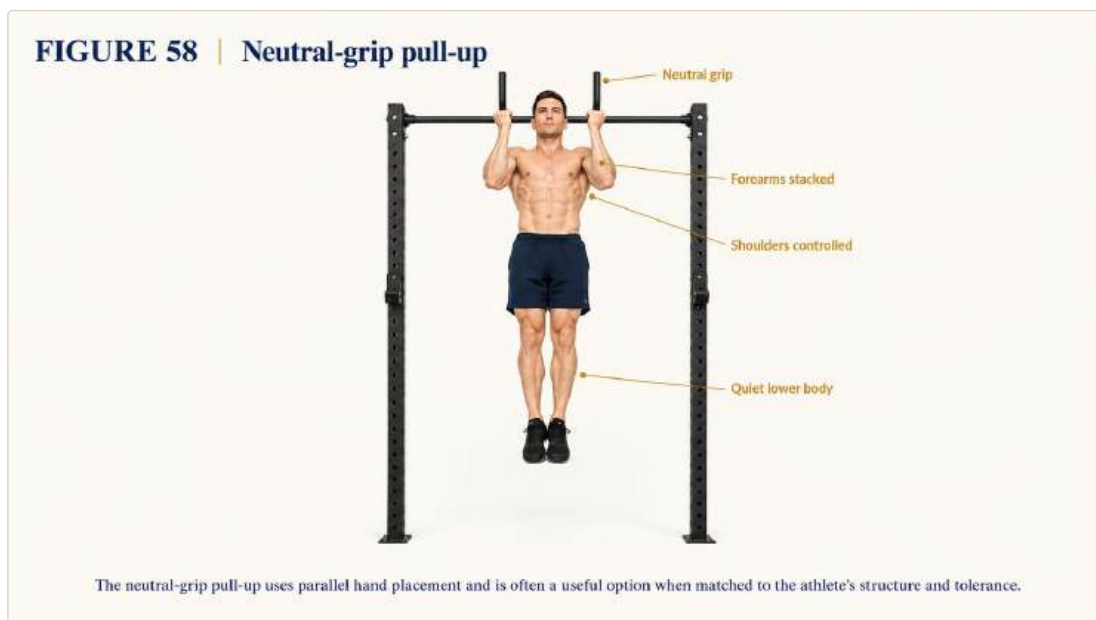
CHAPTER 58 · PART V — TECHNIQUE VARIABLES

Neutral-grip pull-up

The neutral grip, palms facing each other, sits between the chin-up and pull-up in muscular bias and is often the most shoulder-friendly option, placing the glenohumeral joint in a comparatively comfortable position and giving the brachioradialis a strong line of pull (Chapter 41). It is the low-risk default for irritable shoulders or elbows and a sensible starting grip when tolerance is uncertain.

KEY IDEA

Neutral is the diplomat grip. Balanced demand and a friendly shoulder position make it the safe default when a joint is uncertain.

FIGURE 58

Show the balanced position and the comfortable shoulder angle.

CREDIBILITY & CAUTION

"Shoulder-friendly" is a starting assumption, not a guarantee. Confirm tolerance in the individual and progress on symptom response.

MMSx coaching translation: unsure which grip a cranky joint will tolerate? Start neutral, then move toward the goal grip as tolerance allows.

CHAPTER 59 · PART V — TECHNIQUE VARIABLES

Wide, medium and narrow grips

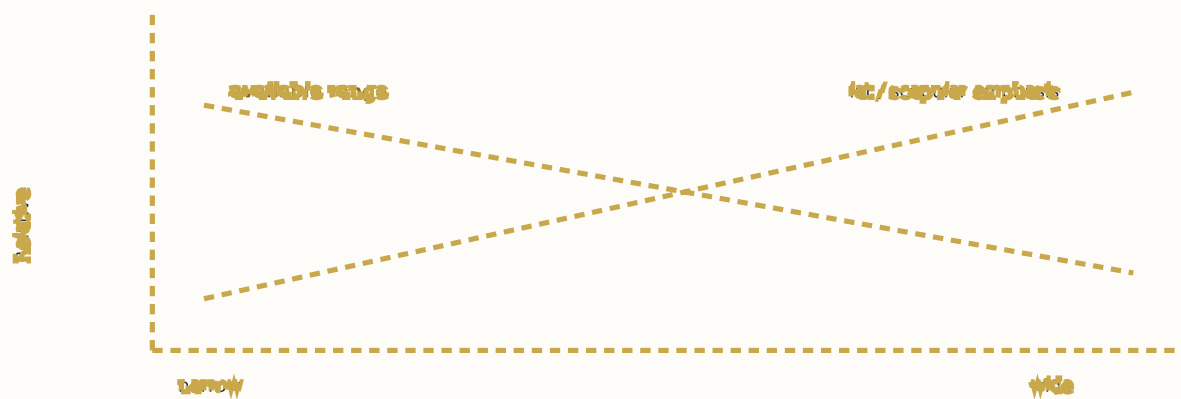
Width is a second axis on top of orientation. Wider grips tend to raise latissimus and scapular emphasis and shorten the range, while narrower grips increase elbow-flexor involvement and lengthen the range; forearm orientation contributes independently of width (Lusk et al., 2010; Andersen et al., 2014). The differences are real but modest, and should be chosen for emphasis and comfort rather than treated as a hierarchy of "best".

KEY IDEA

Width shifts emphasis and range, not virtue. Choose it to bias the target and fit the shoulder, not because one width is universally superior.

Figure 59.1 · Emphasis and range vs grip width (illustrative)

SCHEMATIC



Wider grips raise lat/scapular emphasis but shorten available range; narrower grips do the reverse. Illustrative of the direction shown in EMG/kinematic work.

FIGURE 59.2

FIGURE 59 | Wide, medium and narrow grips



Wide, medium and narrow grips present different constraints, so the best choice depends on goal, comfort, structure, and tolerance.

Show the width continuum and its trade-offs.

MMSx coaching translation: use width to fine-tune emphasis and spare a joint — not to chase a mythical "best" grip.

CHAPTER 60 · PART V — TECHNIQUE VARIABLES

Tempo, pause and isometric variants

Tempo turns one exercise into several. Slow eccentrics and controlled concentrics raise time under tension and control; paused reps at the sticking region or the top build position-specific strength; isometric holds train a single angle without movement (Chapters 17 and 19; Schoenfeld et al., 2017). These variants are precise tools for attacking a named phase — the mid-range stall, the weak top, the uncontrolled descent — rather than general "difficulty".

KEY IDEA

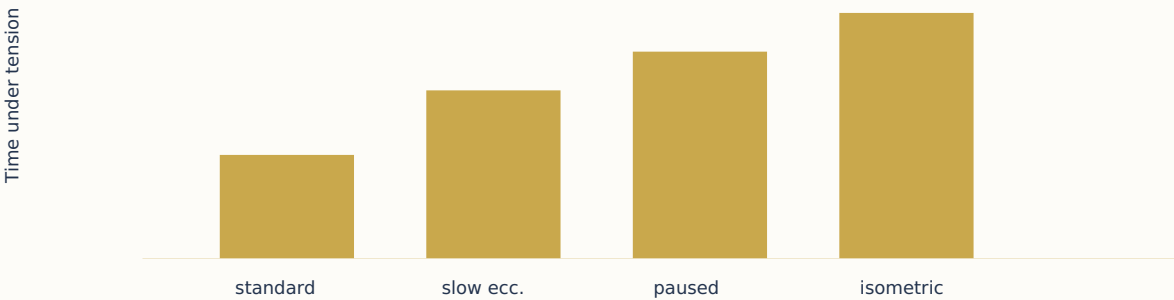
Tempo is a scalpel, not a dial. Use pauses and isometrics to load the exact phase where the athlete fails, instead of just making the whole rep harder.

Table 60.1. Tempo variants and their targets

Variant	What it trains	Best applied to
Slow eccentric	Control, eccentric strength, TUT.	Uncontrolled descent (phase 6).
Paused mid-range	Sticking-region strength.	Mid-range stall (phase 4).
Paused top	Top-range and scapular finish.	Weak or incomplete finish (phase 5).
Isometric hold	Angle-specific strength, low velocity.	Any single limiting angle.

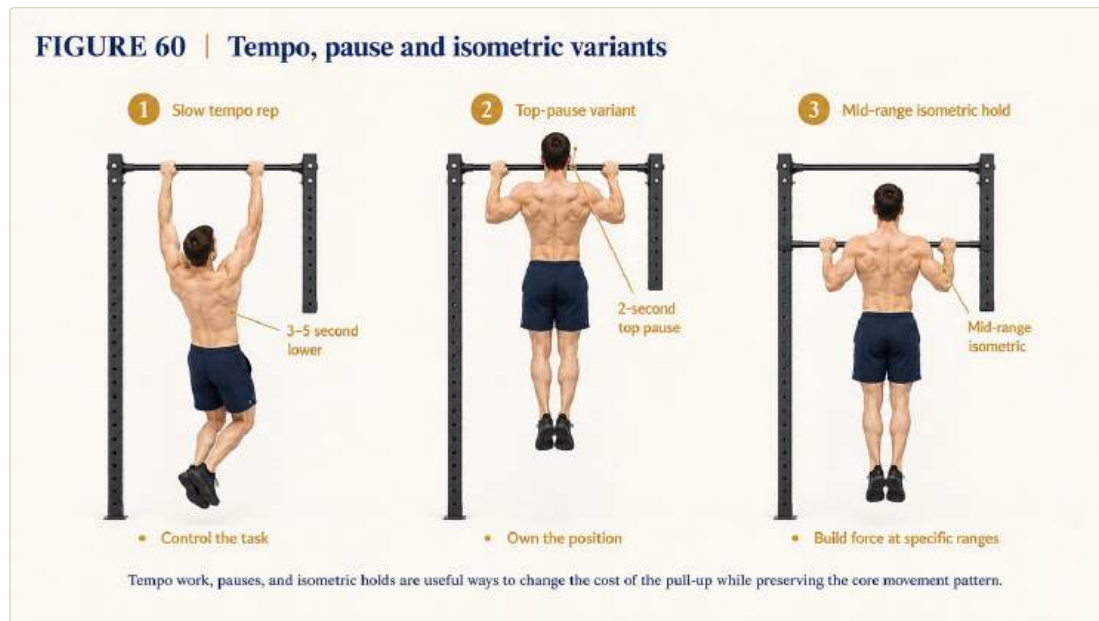
Figure 60.1 · Time under tension by tempo variant (illustrative)

SCHEMATIC



Tempo variants extend time under tension and shift where the load is concentrated.

Part VI now uses these phases and variants to build a full progression from the first assisted rep to advanced weighted pulling.

FIGURE 60.2

Show the paused and isometric positions used to attack specific phases.

MMSx coaching translation: match the tempo tool to the failing phase. Slow the descent, pause the sticking point, hold the top — one variant per problem.

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PART VI

Chapters 61 – 72

Progression From Beginner to Advanced

The phases and variables of Part V now become a ladder. This part builds capacity in defined rungs — from the first supported hang to advanced weighted and density work — governed throughout by a single rule: progress only when the same standard is repeatable, and change one variable at a time.

61 · On-ramp

62 · Hang

63 · Scapular ladder

64 · Assisted

65 · Eccentric

66 · Isometric

67 · First strict rep

68 · Volume

69 · Hypertrophy

70 · Weighted

71 · Density

72 · 24-week plan

CHAPTER 61 · PART VI — PROGRESSION

Absolute beginner on-ramp

The on-ramp answers one question: what is the least costly task that still builds toward a pull-up? For an absolute beginner who cannot yet hang, the answer is rarely the bar itself — it is horizontal rows, pulldowns and supported holds that develop the pattern and the tissue tolerance without the full body-weight demand. Progression is then a matter of moving up the ramp only when the current rung is repeatable (ACSM, 2009).

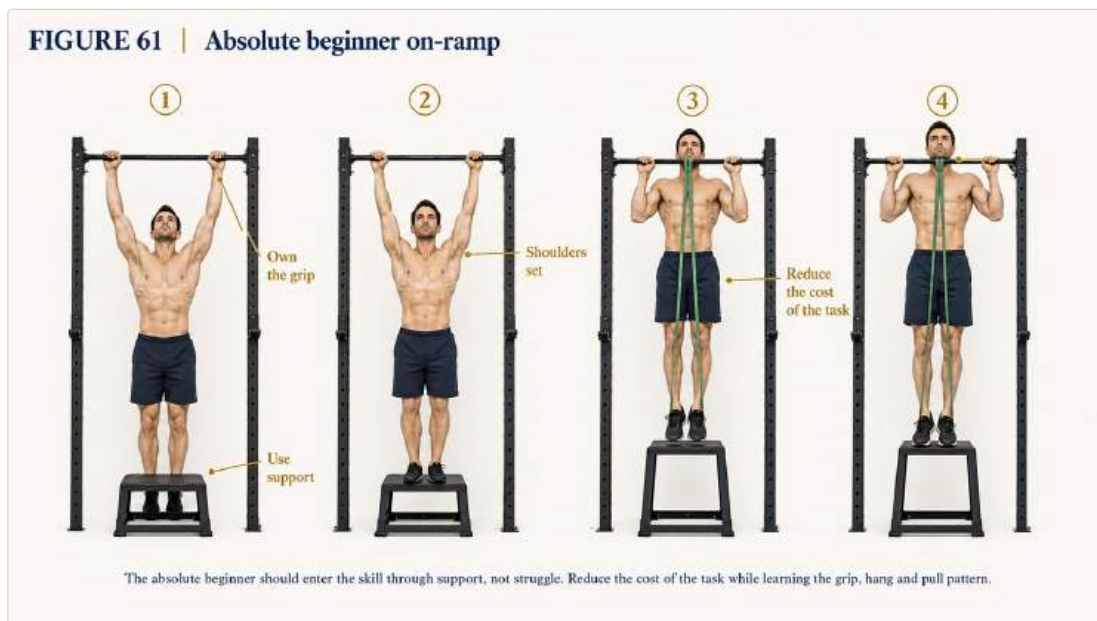
KEY IDEA

Start below the bar if the bar is too much. The on-ramp is a sequence of least-costly useful tasks, each held until it is repeatable, not a leap to the full movement.



Flowchart 61.1. The on-ramp: enter at the athlete's current capacity, not at the bar.

FIGURE 61



Show the least-costly entry tasks that build toward the first assisted rep.

MMSx coaching translation: if the bar is too much today, build the pattern below it. The pull-up is the destination, not the starting line.

CHAPTER 62 · PART VI — PROGRESSION

Dead hang and active hang progressions

The hang builds two things the pull needs: grip endurance and a controlled shoulder platform (Chapters 7 and 25). Progression is measured in hold time and quality — from a short supported hang to a sustained active hang with the scapulae set. Because grip so often limits early pulling, hang time is one of the most transferable first metrics to build.

KEY IDEA

Buy grip and platform with hangs before you spend them on pulls. Hold time is an honest, transferable early measure of readiness.

Figure 62.1 · Hang-time progression over weeks (illustrative)

SCHEMATIC



Hold time rises with consistent exposure; the active hang is progressed once the passive hang is comfortable.

FIGURE 62.2

FIGURE 62 | Dead hang and active hang progressions



Dead hang and active hang are different preparations. The progression is to learn a calm passive hang, then organise the shoulder platform and own the active position.

Show the hang progression from supported to active.

MMSx coaching translation: if grip fails first, hang more. Time on the bar is the cheapest early progress an athlete can make.

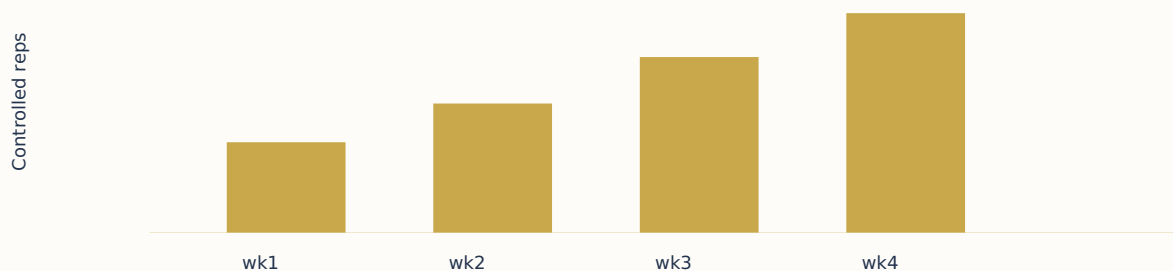
CHAPTER 63 · PART VI — PROGRESSION

Scapular pull-up ladder

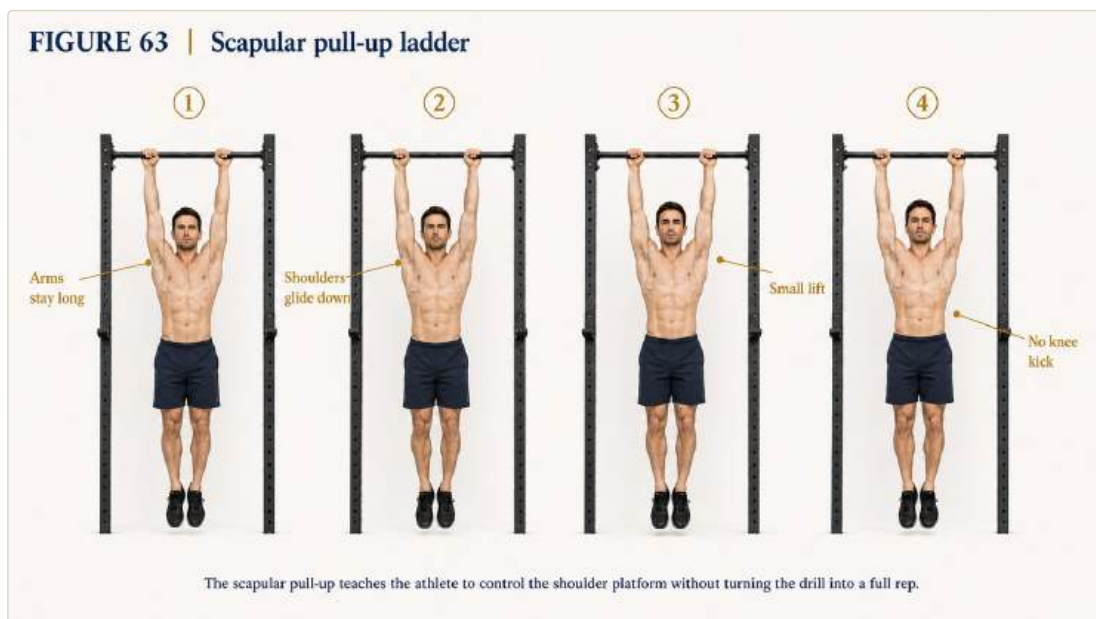
The scapular pull-up trains the initiation phase in isolation: from an active hang, the athlete depresses and retracts the scapulae to raise the body a few centimetres without bending the elbows. It builds the lower-trapezius and serratus control that the full pull depends on (Chapters 42 and 45; Ekstrom et al., 2003), and it is the rung that most reliably fixes a weak or unset platform.

KEY IDEA

Train the platform before the pull. Scapular pull-ups isolate the set-and-depress action every strict rep begins with.

Figure 63.1 · Scapular pull-up ladder — controlled reps by week (illustrative)**SCHEMATIC**

Quality reps progress only when the scapular set holds cleanly — never by adding sloppy volume.

FIGURE 63.2

Show the isolated depress-and-retract action.

MMSx coaching translation: if the shoulder never sets, drill scapular pull-ups until the platform is automatic — then add the elbows.

CHAPTER 64 · PART VI — PROGRESSION

Assisted chin-up progression

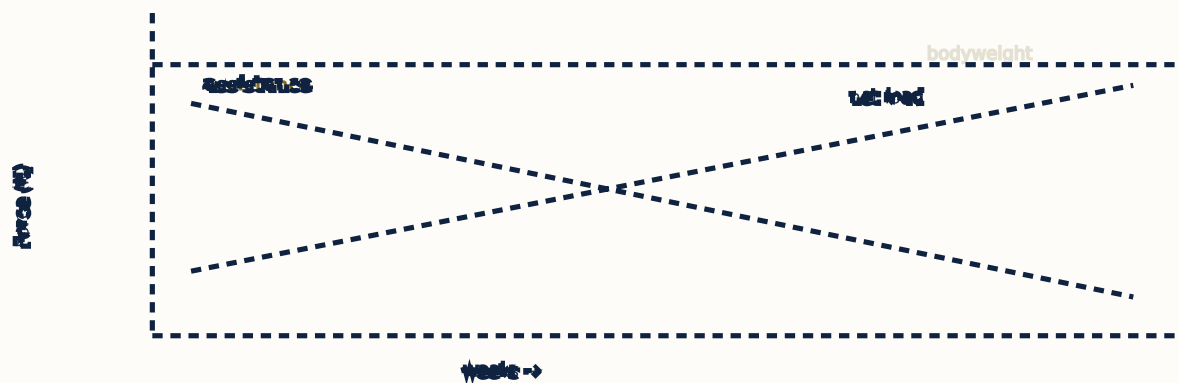
Assistance lets the full pattern be practised below full load, then withdrawn as capacity rises (Chapters 13, 22 and 23). The key is to reduce assistance in small, deliberate steps so the net effective load rises gradually toward body weight — a progression that is legible when written in net load rather than "band colour" (ACSM, 2009).

KEY IDEA

Assistance is a dial to turn down, not a crutch to keep. Reduce it in small steps so net load climbs toward body weight without the pattern breaking.

Figure 64.1 · Assistance withdrawn → net load rises toward bodyweight

SCHEMATIC

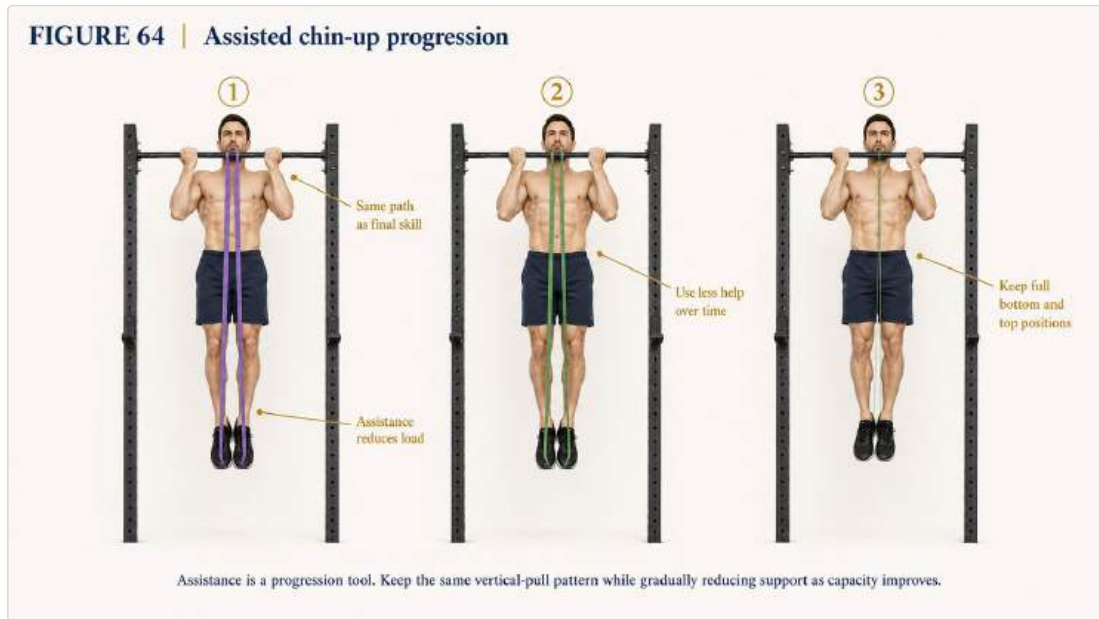


As assistance falls week to week, net load rises to meet body weight — the bridge to the first strict rep.

WORKED NOTE · NET LOAD STEPS (80 KG)

Wk1 –25 kg → 539 N · Wk3 –15 kg → 638 N · Wk6 –5 kg → **736 N** → body weight

Small, tracked reductions keep the pattern intact while demand climbs.

FIGURE 64.2

Show assistance withdrawn step by step.

MMSx coaching translation: write assistance in kilograms removed, not band colours. It makes progress measurable and the first strict rep predictable.

CHAPTER 65 · PART VI — PROGRESSION

Eccentric-only progression

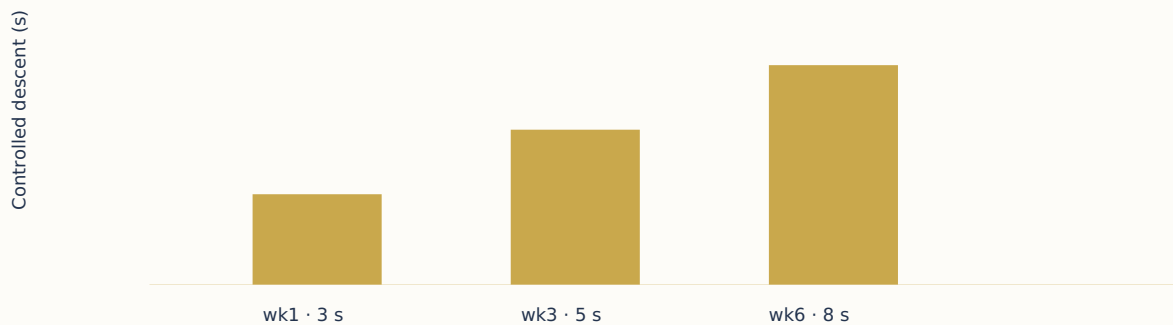
An athlete who cannot yet lift the body can often lower it under control, because eccentric strength exceeds concentric. Eccentric-only reps — jumping or stepping to the top, then lowering slowly — build strength through the full range and, crucially, through the sticking region, making them one of the most effective bridges to a first strict rep (Chapter 17). Progression lengthens the descent and reduces any assistance to the top.

KEY IDEA

If you can't yet pull up, learn to lower slowly. Eccentric-only work builds full-range strength and is the fastest bridge to the first rep.

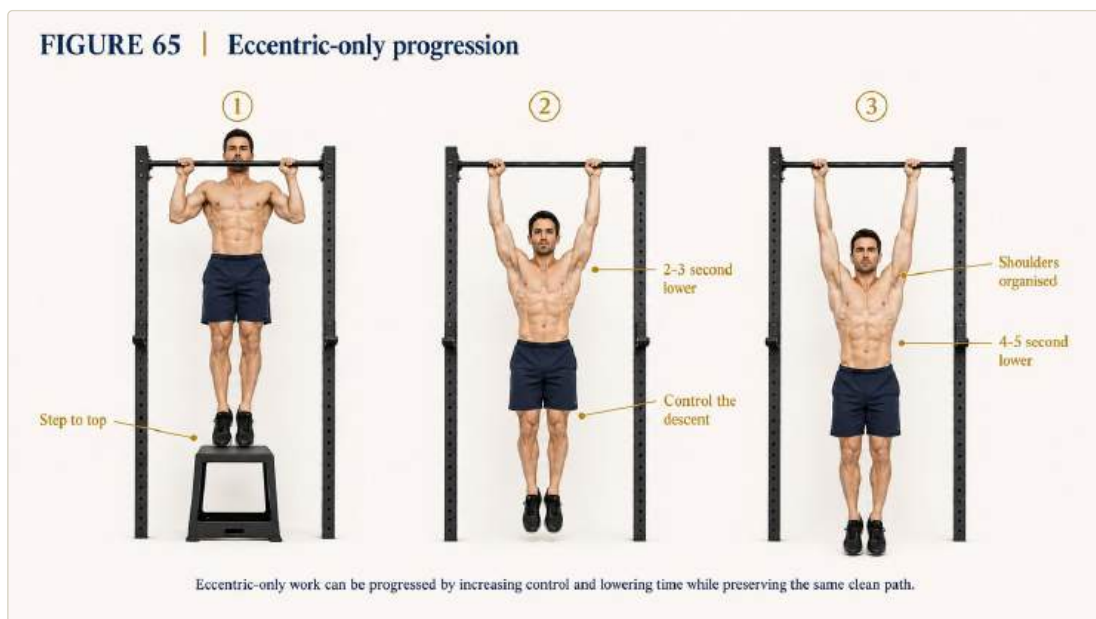
Figure 65.1 · Eccentric descent duration progression (illustrative)

SCHEMATIC



Lengthening the controlled descent progressively overloads the eccentric through the sticking region.

FIGURE 65.2



Show the eccentric-only method and the controlled lower.

MMSx coaching translation: can't pull up yet? Get to the top any way you can, then lower for as long as you can control. Lengthen that time weekly.

CHAPTER 66 · PART VI — PROGRESSION

Isometric hold progression

Isometric holds build strength at a specific angle without movement, which makes them ideal for attacking a named sticking angle or a weak top (Chapter 60). Holds at the top, at the sticking region and at the bottom of a controlled position each train a different part of the range; progression lengthens the hold or moves it to a harder angle.

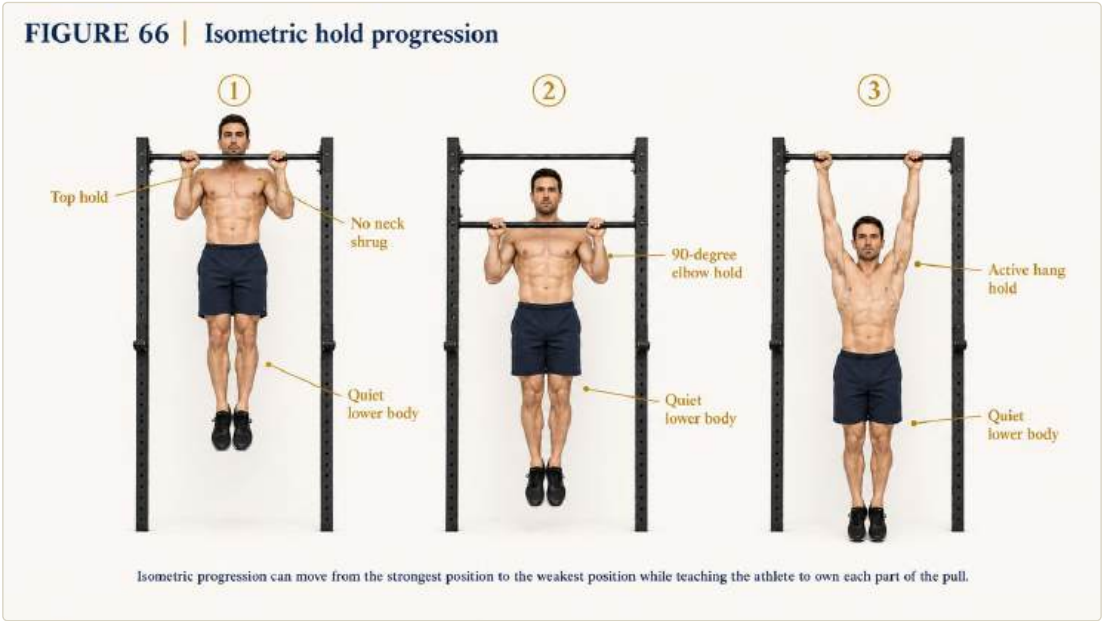
KEY IDEA

Hold where you're weak. Isometrics load a single angle precisely — the tool for a specific stall rather than general difficulty.

Table 66.1. Isometric hold positions

Position	Targets	Progress by
Top (chin over)	Finish strength, scapular retraction.	Longer hold; then add load.
Mid (sticking)	The failure angle directly.	Longer hold at the exact angle.
Bottom (active)	Platform control from the hang.	Longer hold with scapulae set.

FIGURE 66



Show the three hold positions and their targets.

MMSx coaching translation: pick the angle where they fail and hold it. Add seconds, then add load.

CHAPTER 67 · PART VI — PROGRESSION

First strict rep strategy

The first strict rep is where the earlier rungs converge: near-zero assistance, a controlled full-range eccentric, and an isometric hold that covers the sticking angle together signal readiness. The strategy is to combine them — greasing the pattern with frequent, low-fatigue exposure — rather than grinding failed attempts, which teaches poor mechanics (Chapter 8).

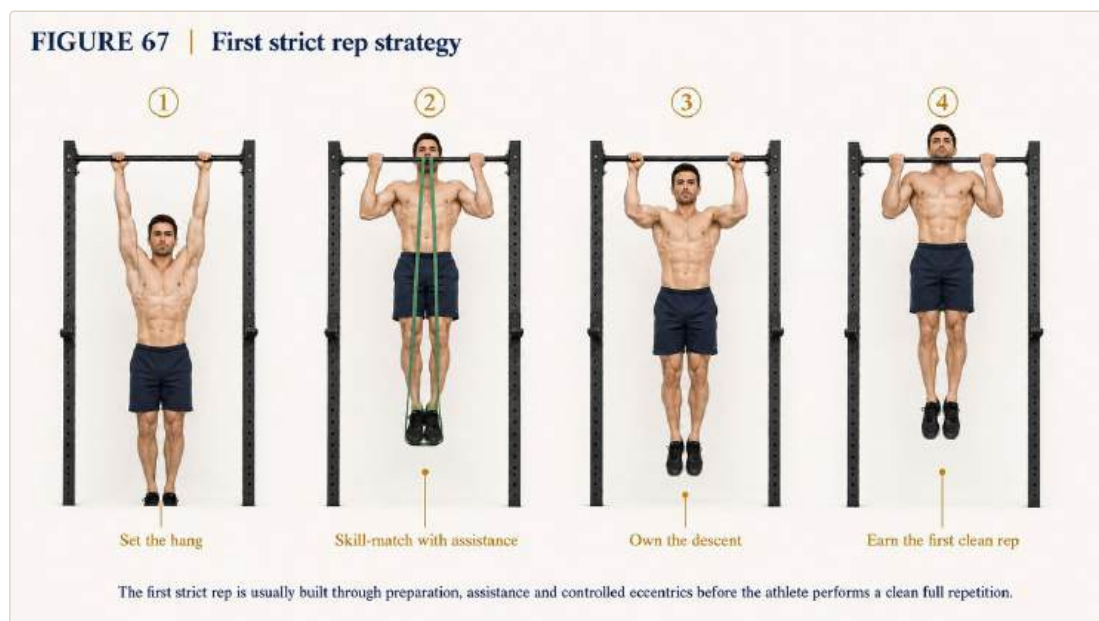
KEY IDEA

The first rep is a convergence, not a leap. When assistance nears zero, the eccentric is controlled and the sticking hold is solid, the rep is already close — practise it fresh, not fatigued.



Flowchart 67.1. Readiness for the first strict rep is a convergence of three rungs.

FIGURE 67



Show the convergence into the first strict repetition.

MMSx coaching translation: don't grind failed reps to get the first one. Practise the near-rep fresh and often; it arrives when the three rungs meet.

CHAPTER 68 · PART VI — PROGRESSION

Volume building after the first rep

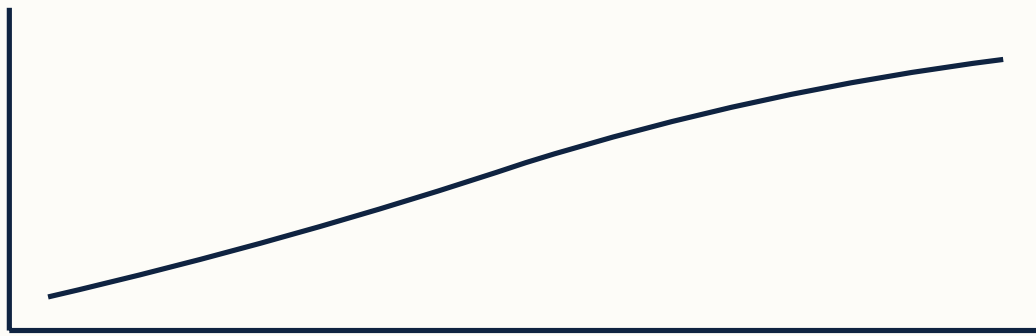
After the first rep, the task changes from access to accumulation: building repeatable volume without losing the standard. Frequent low-rep exposure (for example, several sets of one to three clean reps across the week) builds volume faster than occasional maximal sets, and total quality volume — not a single hard set — drives the adaptation (Schoenfeld et al., 2017; Grgic et al., 2018).

KEY IDEA

After the first rep, accumulate quality. Frequent small sets beat rare maximal grinds for building repeatable volume.

Figure 68.1 · Weekly quality reps after the first strict rep (illustrative)

SCHEMATIC



Total weekly quality volume rises gradually; reps are added only while the standard holds.

FIGURE 68.2

FIGURE 68 | Volume building after first rep



After the first strict rep, volume is often built through repeat singles, short rests and assisted back-off work rather than immediate breakdown sets.

Show frequent quality sets against a rare grind.

MMSx coaching translation: after the first rep, do a little often. Add weekly reps while the standard holds; stop adding when it slips.

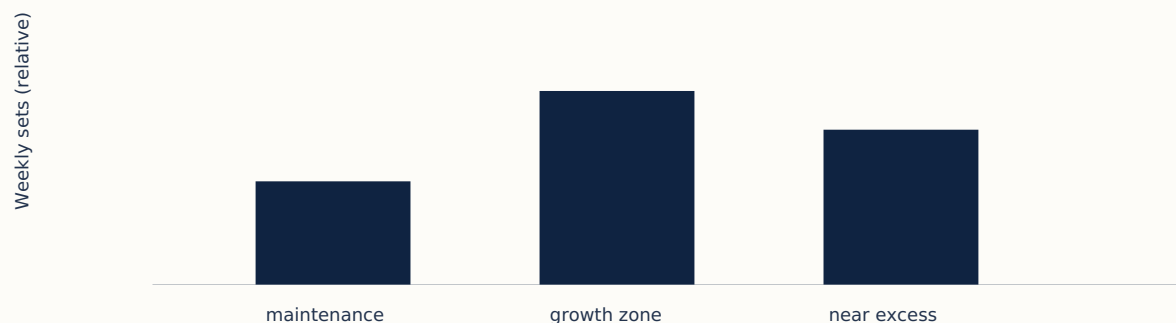
CHAPTER 69 · PART VI — PROGRESSION

Hypertrophy-focused vertical pulling

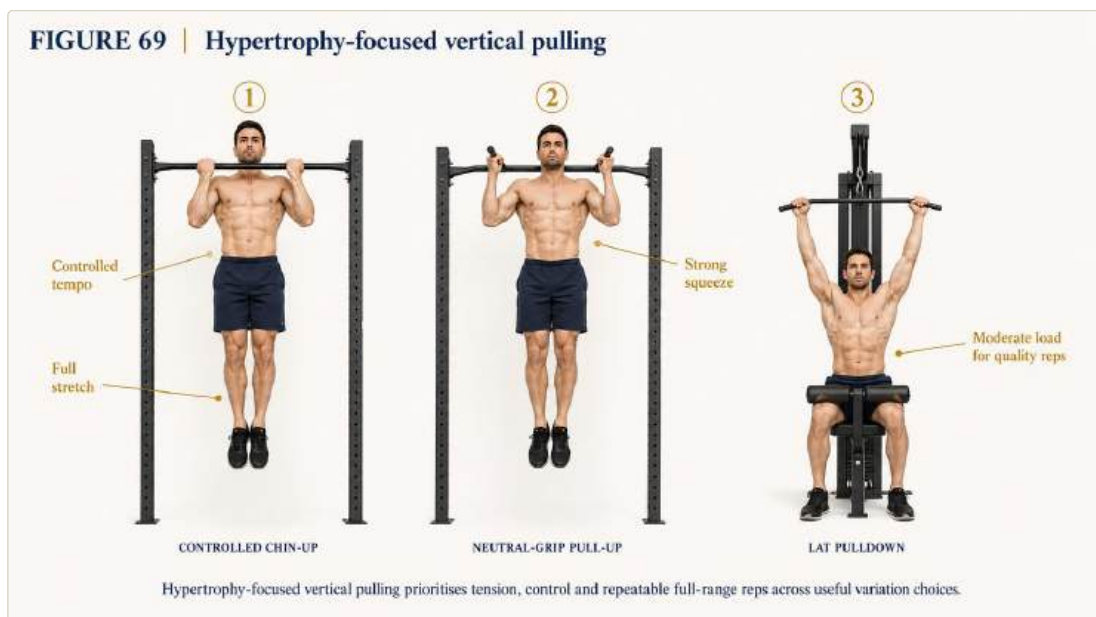
When size is the goal, the levers change: moderate loads taken close to failure, full range, and enough weekly volume to drive growth, with load and reps chosen so the working sets sit in a hypertrophy-friendly zone (Schoenfeld et al., 2017; Rhea et al., 2003). Vertical pulling builds the latissimus, teres major and elbow flexors especially; grip and range choices (Parts IV–V) bias which of these grows most.

KEY IDEA

For size, chase quality volume near failure through full range. Grip and width decide which pulling muscles take the growth stimulus.

Figure 69.1 · Weekly set-volume landmarks for hypertrophy (illustrative)**SCHEMATIC**

A working range of weekly volume drives growth; too little maintains, too much erodes recovery. Individualise around it.

FIGURE 69.2

Show full-range reps that maximise the growth stimulus.

MMSx coaching translation: for size, take moderate loads near failure through full range, and add weekly sets to the point where recovery still holds.

CHAPTER 70 · PART VI — PROGRESSION

Weighted chin-up progression

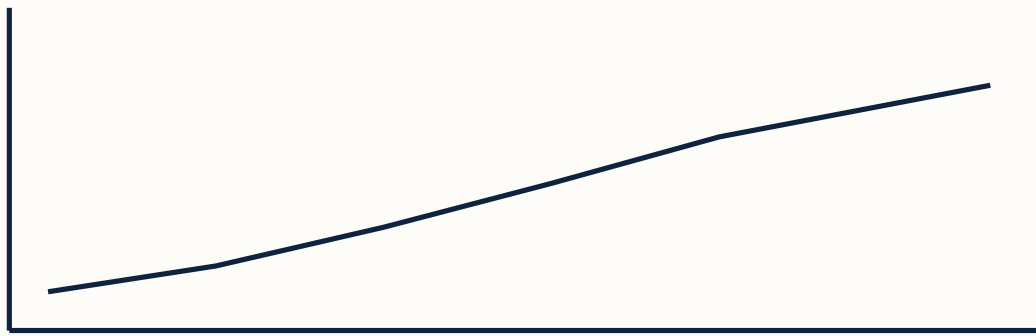
Once strict reps are secure, added load drives maximal strength (Chapters 4 and 13). Progression is a small, steady rise in external weight — often a couple of kilograms per step — while mechanics and the finish standard hold. Weighted work is the top of the strength ladder, and it belongs only on a stable strict base (Zatsiorsky & Kraemer, 2006; ACSM, 2009).

KEY IDEA

Add weight in small steps, on a strict base. The rep standard, not the plate, decides when to progress.

Figure 70.1 · Added load progression over a block (illustrative)

SCHEMATIC

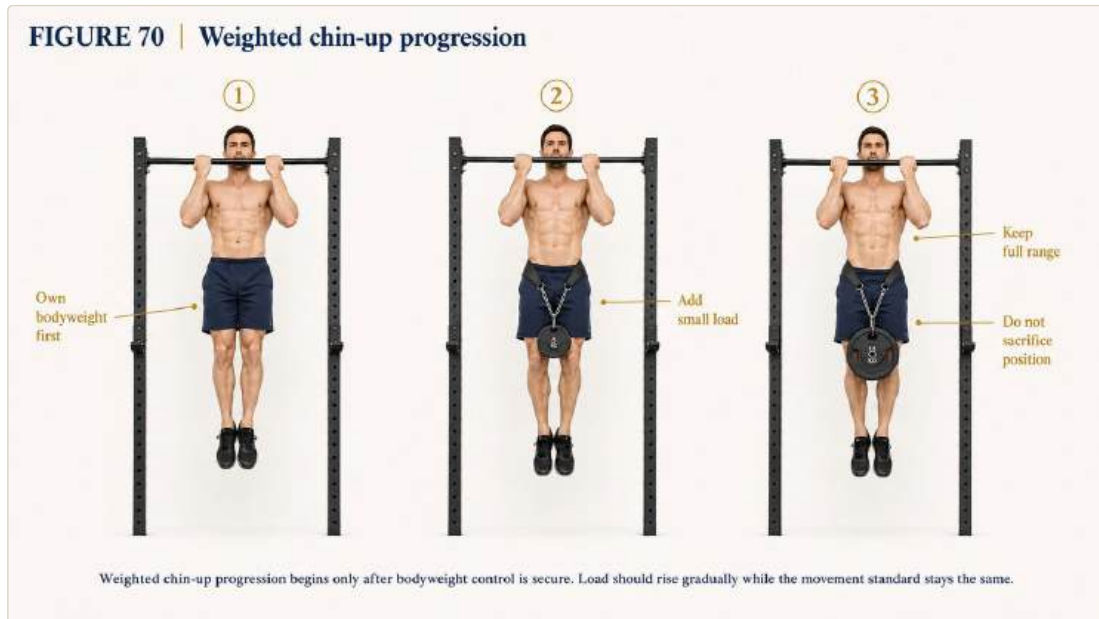


Small, steady increments preserve mechanics while raising net load above body weight.

WORKED NOTE · NET LOAD WITH ADDED WEIGHT (80 KG)

+10 kg: $(80 + 10) \cdot 9.81 \approx 883 \text{ N}$ · +15 kg: $(80 + 15) \cdot 9.81 \approx 932 \text{ N}$

Each plate step is a defined rise in net load — progress it only when the finish standard holds.

FIGURE 70.2

Show a strict finish maintained under added weight.

MMSx coaching translation: add a little weight often, and only while the chin still clears cleanly. The standard gates the plate.

CHAPTER 71 · PART VI — PROGRESSION

Advanced density methods

Density methods raise the work done per unit time rather than the load per rep: clusters (short intra-set rests), every-minute-on-the-minute schemes, and reduced rest between sets all increase total quality volume while managing fatigue. They suit advanced athletes with a secure base who need more stimulus without simply adding weight, and they are governed by the same velocity-loss discipline that stops a set before mechanics degrade (Sánchez-Medina & González-Badillo, 2011; Weakley et al., 2021).

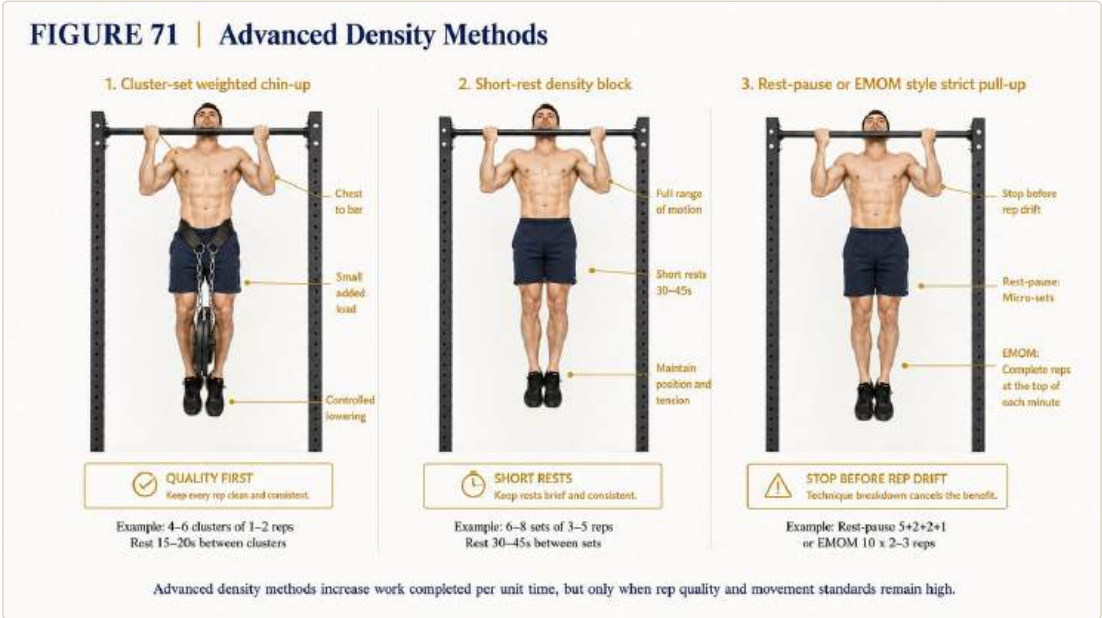
KEY IDEA

Density buys volume with time, not load. Use clusters and short rests to add quality work — and stop each piece on velocity loss, not on form failure.

Table 71.1. Density methods

Method	Structure	Best for
Clusters	Short rests within a set (e.g., 2 reps × several, 15 s rests).	Quality reps at higher load.
EMOM	Fixed reps every minute for a block.	Accumulating volume with control.
Reduced-rest sets	Trim inter-set rest progressively.	Raising work rate over a block.

FIGURE 71



Show how clusters keep quality high while raising density.

MMSx coaching translation: when adding weight isn't wise, add density — more quality work in less time, stopped on velocity loss.

CHAPTER 72 · PART VI — PROGRESSION

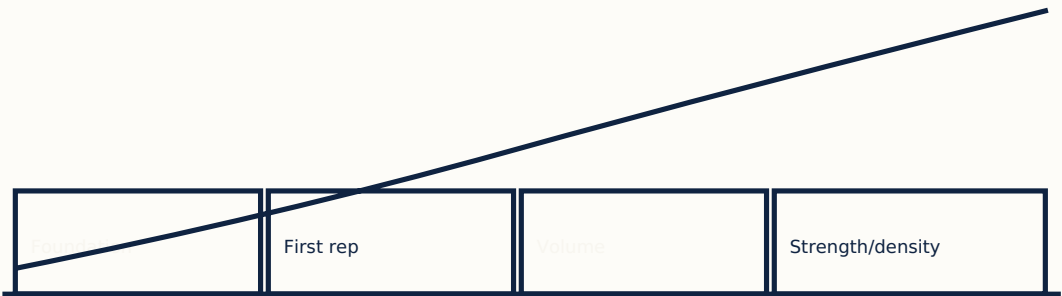
Twenty-four-week global progression

The rungs of this part assemble into one periodised plan. A representative twenty-four-week progression moves through four six-week blocks — foundation, first strict rep, volume accumulation, and strength/density — each building on the last, with a planned lighter week to consolidate before the next block (ACSM, 2009; Rhea et al., 2003). The plan is a template to individualise, not a prescription: the standard-and-retest rule governs every advance.

KEY IDEA

Progress in blocks, not in a straight line. Four six-week phases, each consolidating before the next, take an athlete from the on-ramp to advanced pulling.

Figure 72.1 · Twenty-four-week periodised progression (representative) SCHEMATIC

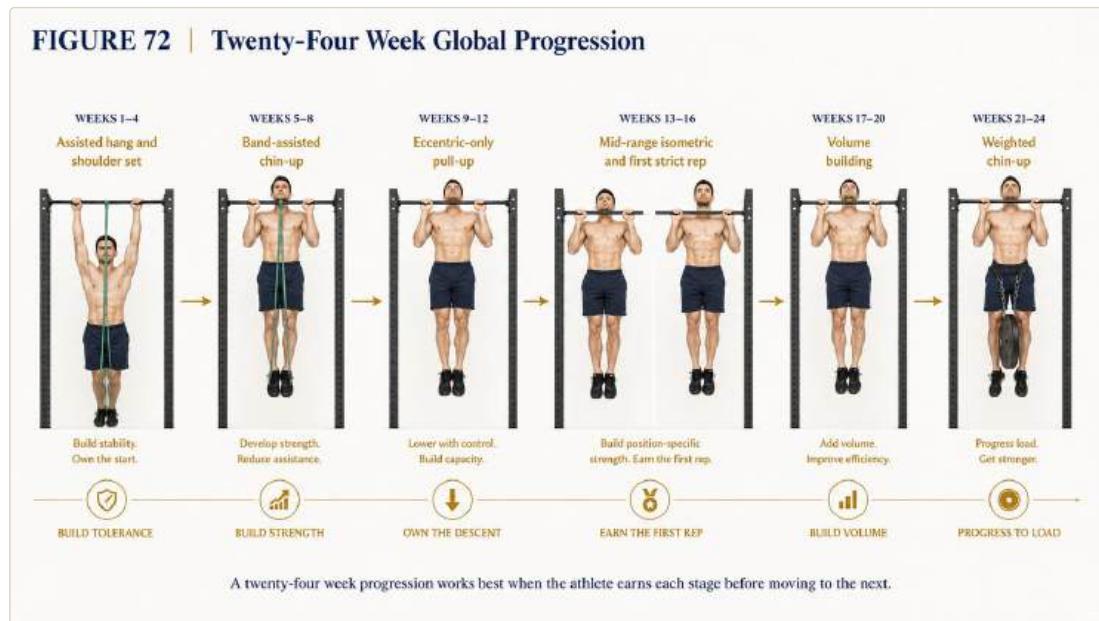


Four six-week blocks with a rising capacity curve; each block consolidates before the next. Individualise around the standard-and-retest rule.

Table 72.1. The four blocks

Block	Weeks	Focus	Exit standard
Foundation	1–6	Hangs, scapular ladder, rows.	Active hang + clean scapular pull-ups.
First rep	7–12	Assisted, eccentric, isometric.	One strict, full-range rep.
Volume	13–18	Frequent quality reps.	Repeatable multi-rep sets.
Strength / density	19–24	Weighted and density work.	Weighted reps or dense quality volume.

Part VII now turns from building capacity to assessing and correcting it — how to test, diagnose faults and coach corrections systematically.

FIGURE 72.2

Show one athlete across the four block exits.

MMSx coaching translation: hand an athlete the four-block map, but let the standard-and-retest rule set the pace. The plan bends to the athlete, not the reverse.

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PART VII

Chapters 73 – 84

Assessment, Coaching and Correction

Building capacity is one skill; reading it is another. This part is the coaching workflow — screen safely, test the links of the chain, diagnose the fault from what you can observe, translate it into one useful cue, and retest before you progress. Correction here is a decision procedure, not a bag of tips.

73 • Screening

74 • Grip/hang

75 • Shoulder

76 • Scapula

77 • Trunk audit

78 • Video

79 • Error→cause

80 • Cue library

81 • Regress/progress

82 • Retest

83 • Beginners

84 • Advanced

CHAPTER 73 · PART VII — ASSESSMENT

First-session screening

The first session begins with safety, not performance. Before loading, the coach screens for red flags — chest pain, neurological signs, acute trauma, progressive weakness, suspected rupture, unexplained or post-surgical symptoms — any of which is a referral, not a training decision (Lafrance et al., 2022; Desmeules et al., 2025). Only when the screen is clear does assessment proceed to the links of the chain: grip, shoulder, scapula and trunk.

KEY IDEA

Screen before you load. The first decision of the first session is whether to train at all — and a red flag ends that decision in favour of referral.



Flowchart 73.1. First-session screening: safety gate before assessment.

CREDIBILITY & CAUTION

Red flags — chest pain or breathlessness, neurological signs, acute trauma, progressive weakness, sudden painful give-way, night or unremitting pain, post-surgical restriction, unexplained symptoms — require qualified evaluation before any loading.

FIGURE 73



Show the safety-first order of the first session.

MMSx coaching translation: the first thing you assess is whether to assess at all. Clear the red flags, then coach.

CHAPTER 74 · PART VII — ASSESSMENT

Grip and hang tolerance checks

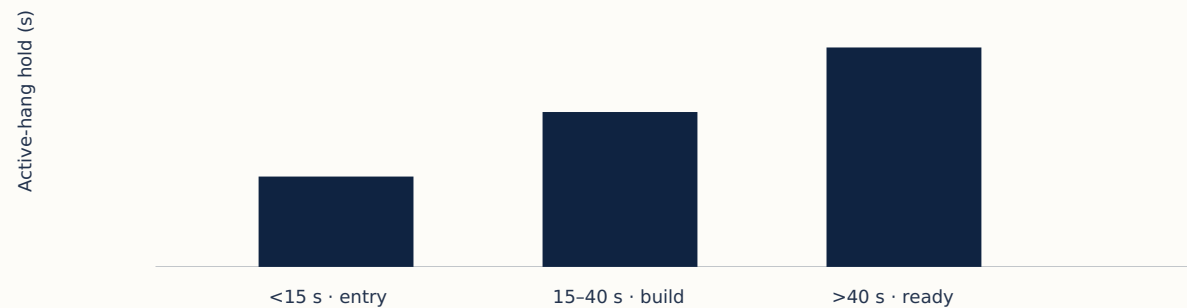
Because grip so often limits early pulling (Chapters 25 and 41), the hang is the first practical test. A short active hang reveals grip endurance, shoulder tolerance and the athlete's ability to set the platform, and its hold time gives an objective baseline to progress against.

KEY IDEA

The hang is the cheapest, most informative first test. Hold time and quality reveal the grip and platform before a single pull is attempted.

Figure 74.1 · Active-hang tolerance bands (illustrative)

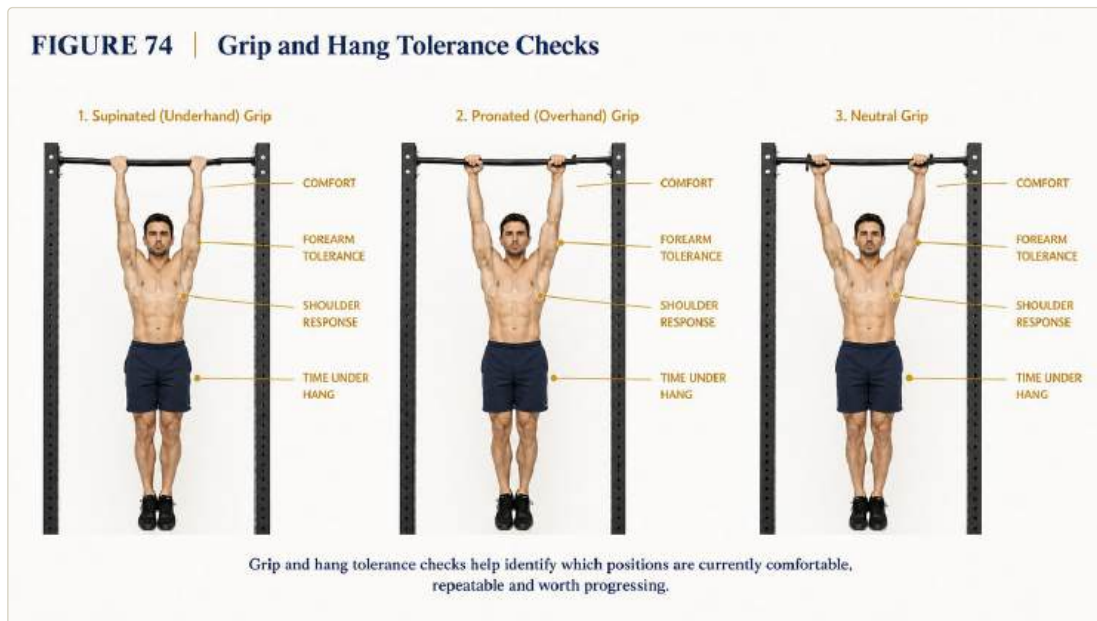
SCHEMATIC



Indicative hold-time bands for classifying readiness; individualise the thresholds.

Table 74.1. Grip and hang checks

Check	What it reveals	Flag
Active hang hold	Grip endurance and platform.	Very short hold → grip on-ramp.
Grip type comfort	Tolerant orientation.	Pain in one grip → change grip.
Open-hand vs hook	Friction vs mechanical demand.	Early slip → chalk/hook.

FIGURE 74.2

Show the baseline hang test and what the coach watches.

MMSx coaching translation: time an active hang first. It tells you where to start and gives you a number to beat.

CHAPTER 75 · PART VII — ASSESSMENT

Shoulder range and symptom screen

The shoulder screen checks that the athlete has enough overhead range, can control it, and tolerates loading without provocative symptoms (Chapters 28 and 34). The output is a traffic-light decision: a clear, pain-free, controlled range is a green light to load; a nigggle that settles within the session is amber and dosed carefully; any red flag is a referral (Cools et al., 2014; Lafrance et al., 2022).

KEY IDEA

Screen the shoulder to a traffic light. Green loads, amber is dosed and watched, red refers — no all-or-nothing decisions.

GREEN

Full, controlled, pain-free range → load and progress normally.

AMBER

Minor, settling symptoms → reduce range/grip/load; monitor response.

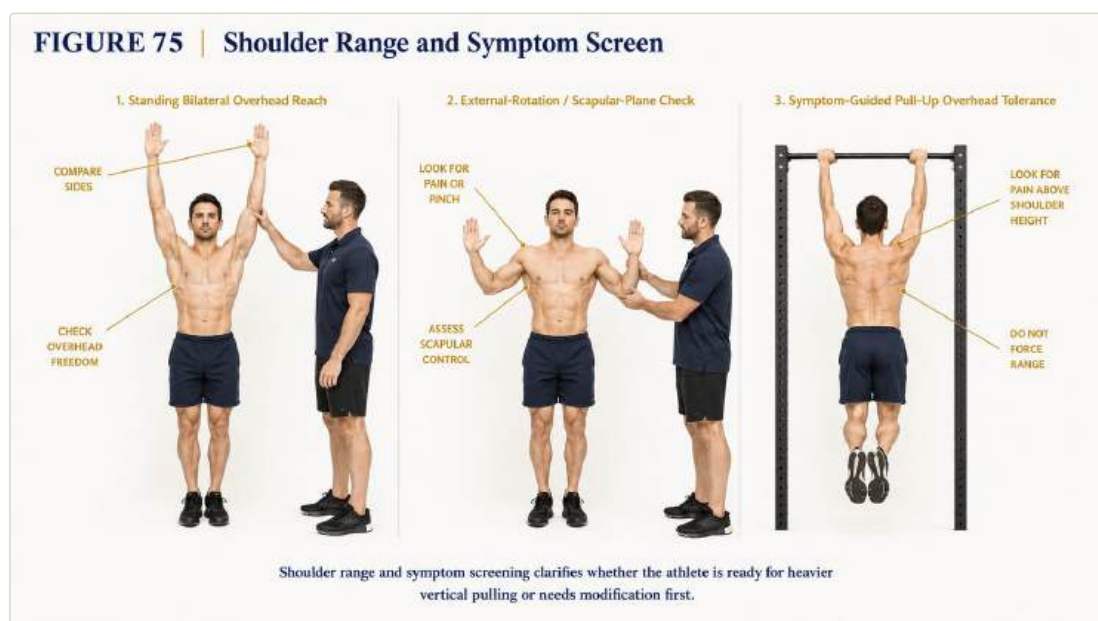
RED

Red-flag or worsening symptoms → stop and refer.

CREDIBILITY & CAUTION

Painful arc, pinching, night pain, weakness or a sense of instability under load moves the decision toward amber or red. When in doubt, dose down and reassess; refer persistent or worsening presentations.

FIGURE 75



Show the range and symptom checks feeding the traffic-light decision.

MMSx coaching translation: green, amber, red. Load the green, nurse the amber, refer the red — and never argue a red into an amber.

CHAPTER 76 · PART VII — ASSESSMENT

Scapular control tests

Because the scapula is the platform (Chapter 29), its control is tested directly: watching for winging, drift or dyskinesia during a slow pull or a scapular pull-up, and checking whether the athlete can set and hold the scapula on cue (Kibler & Sciascia, 2010; Cools et al., 2014). Poor scapular control found here explains many downstream faults and points straight to the scapular ladder of Chapter 63.

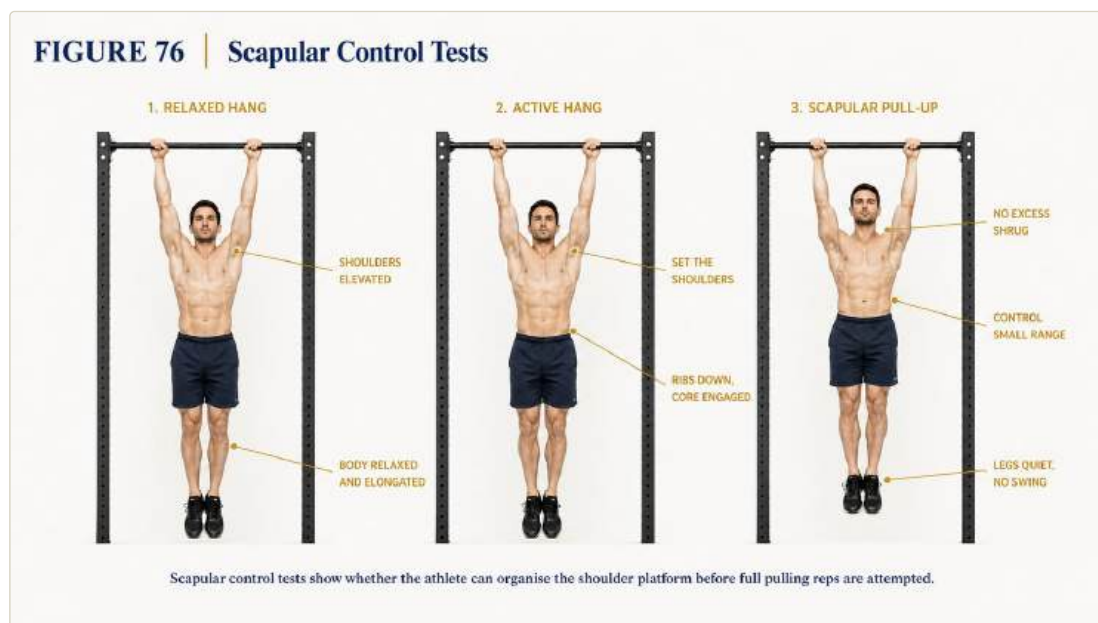
KEY IDEA

Test the platform before blaming the pull. Winging or drift found here is often the true cause of a fault seen higher up the chain.

Table 76.1. Scapular control checks

Test	Positive finding	Points to
Scapular pull-up hold	Cannot set/hold depression.	Lower-trap/serratus work (Ch 63).
Slow-pull observation	Winging or medial-border drift.	Serratus control (Ch 45).
Set-on-cue	Cannot organise the platform to instruction.	Motor control, not mobility (Ch 34).

FIGURE 76



Contrast a set platform with dyskinesia for the coach's eye.

MMSx coaching translation: if the shoulder blade wings or wanders, fix the platform first — most faults above it will follow.

CHAPTER 77 · PART VII — ASSESSMENT

Trunk and body-line audit

The trunk audit checks whether the athlete can brace, hold a hollow line and resist the swing that leaks force (Chapters 20, 31 and 47). It is quickly done: ask for a braced active hang and watch for arching, and observe the first reps for a body line that stays quiet or begins to pendulum.

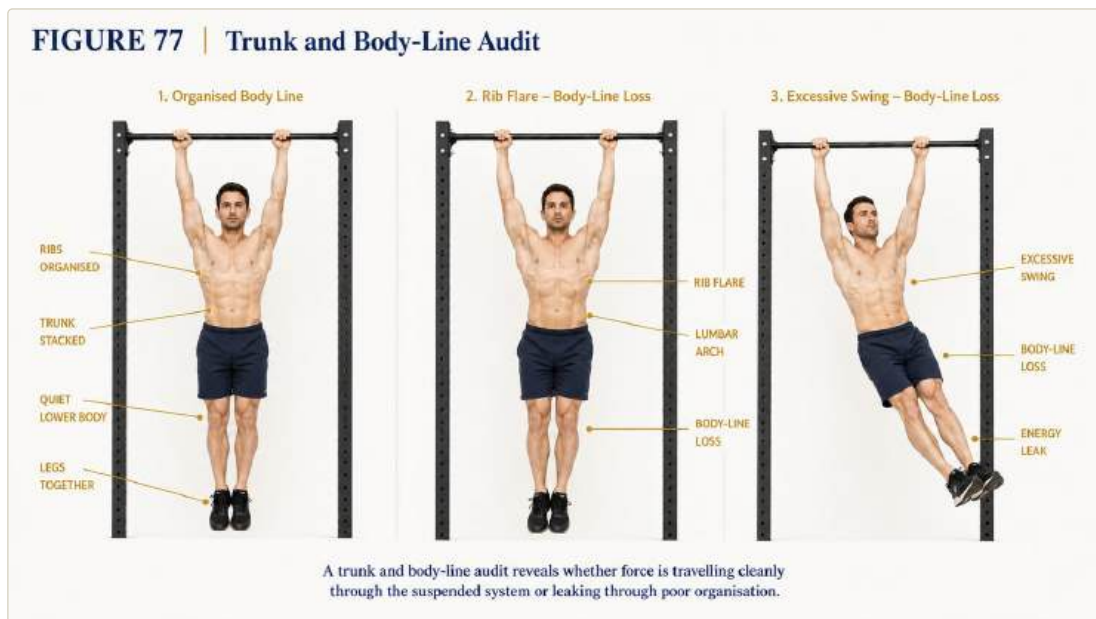
KEY IDEA

Audit the body line early. A trunk that cannot brace turns every pull into a swing, and no arm cue fixes that.

Table 77.1. Body-line audit

Observation	Fault	First correction
Rib flare at hang	Cannot brace; over-extended trunk.	Cue exhale-and-brace; hollow hold.
Swing at initiation	Loose legs; pendulum.	Squeeze legs; tension the hollow.
Arch under fatigue	Losing brace late in set.	End set earlier; build trunk endurance.

FIGURE 77



Show the quiet body line against the pendulum.

MMSx coaching translation: if the body swings, coach the trunk, not the arms. A braced hollow line is a prerequisite, not a finishing touch.

CHAPTER 78 · PART VII — ASSESSMENT

Video analysis from front, side and back

Each camera angle reveals different faults, and using only one hides half the problem. The side view shows bar path, body line and range; the front view shows symmetry and grip; the back view shows the scapula and any winging. Filming all three turns subjective impressions into reviewable evidence and lets the coach locate a fault in a specific phase (Chapter 49).

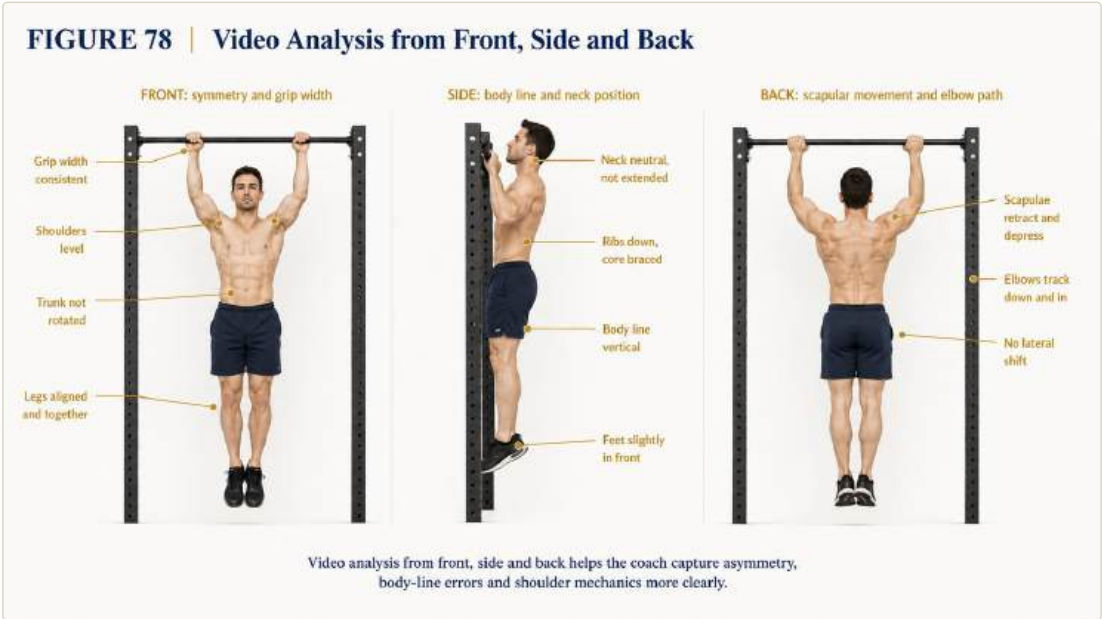
KEY IDEA

Three views, three different faults. The side sees the path, the front sees symmetry, the back sees the scapula — use all three.

Table 78.1. What each view reveals

View	Best for	Typical catch
Side	Bar path, body line, range, tempo.	Swing; short range; sticking stall.
Front	Symmetry, grip, elbow path.	Side-to-side asymmetry; craning.
Back	Scapular set and control.	Winging; medial-border drift.

FIGURE 78



Show the three angles and the fault each is best placed to catch.

MMSx coaching translation: film side, front and back. One angle will flatter a fault the next angle exposes.

CHAPTER 79 · PART VII — CORRECTION

Error-to-cause diagnostic map

The most common coaching mistake is treating the symptom instead of the cause — cueing the elbows when the scapula is the problem, or adding arm work when the grip fails first. This diagnostic map runs the other way: from the observable error, to the likely mechanical cause, to the first correction and the retest. It is the practical heart of Part VII.

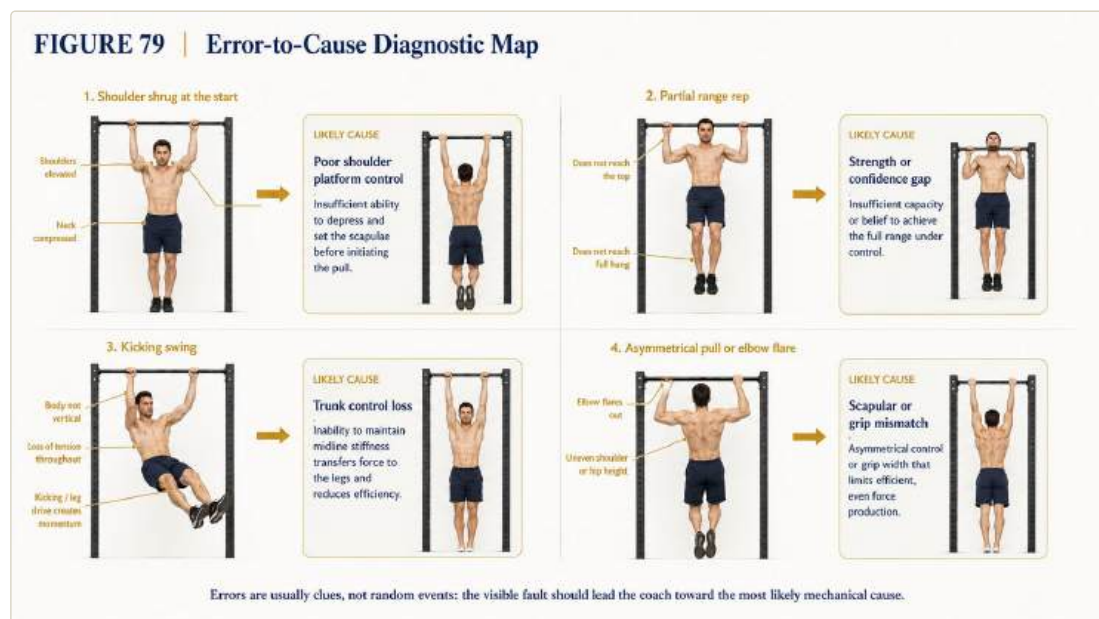
KEY IDEA

Coach the cause, not the symptom. The same visible error can arise from different links of the chain — find the link, then correct it.

Table 79.1. Error-to-cause diagnostic map

Observed error	Likely cause	First correction	Retest
Swing at start	Loose trunk; unset scapula.	Brace + scapular set cue.	Quiet first rep?
Mid-range stall	Elbow/sticking torque limit.	Partial or isometric at that angle.	Bar speed through mid?
Shrug / neck compression	No scapular depression.	Scapular pull-ups; "shoulders down".	Depressed set held?
Half-range at top	Top-range weakness or fatigue.	Paused top; end set earlier.	Clean chin-over?
Early grip slip	Friction/grip endurance.	Chalk/hook; grip work or straps.	Set held to plan?
Winging	Serratus under-control.	Serratus drills; scapular ladder.	Scapula flat on ribs?

FIGURE 79



Design as a printable wall-chart mirroring Table 79.1.

MMSx coaching translation: read the error backwards to its cause. The correction is only right if it targets the link that failed.

CHAPTER 80 · PART VII — CORRECTION

Cue translation library

A cause is only useful once it becomes a cue the athlete can act on. External-focus cues — directing attention to the effect of the movement rather than the body part — generally produce better motor learning than internal, body-part cues (Wulf, 2013; Benjaminse & Otten, 2011). This library translates each common fault into one external cue, because one good cue beats five clever ones (Chapter 8).

KEY IDEA

Translate the cause into one external cue. Aim attention at the outcome, not the muscle, and give a single cue at a time.

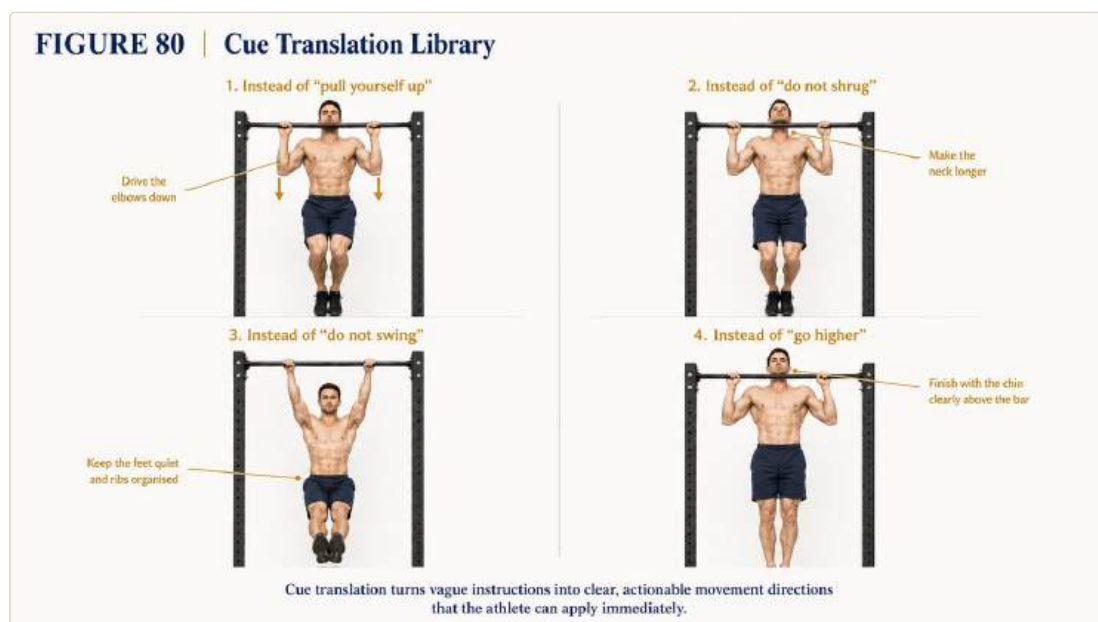
Table 80.1. Fault-to-cue translations (external focus)

Fault	External cue	Avoid (internal)
Unset shoulder	"Pull the bar down to you."	"Contract your lower traps."
Swing	"Keep your body a straight line."	"Squeeze your abs."
Mid-range slow	"Drive the bar past your eyes fast."	"Fire your biceps."
Craning	"Bring your chest to the bar."	"Extend your neck."

EVIDENCE NOTE

External-focus instructions tend to improve movement outcomes and retention relative to internal-focus cues across a range of tasks (Wulf, 2013; Benjaminse & Otten, 2011). Prefer them, and give one at a time.

FIGURE 80



Show where the athlete's attention is directed by each cue.

MMSx coaching translation: cue the outcome, not the muscle, and cue one thing. "Chest to bar" beats a paragraph about scapular mechanics.

CHAPTER 81 · PART VII — CORRECTION

Regression and progression rules

Correction runs on two rules: change one variable at a time, and let the athlete's response — quality, symptom, recovery — decide the direction (Chapters 1 and 8; ACSM, 2009). Regression reduces the cost of the task at exactly the failing point; progression adds a defined increment only when the standard is repeatable. The traffic light governs both.

KEY IDEA

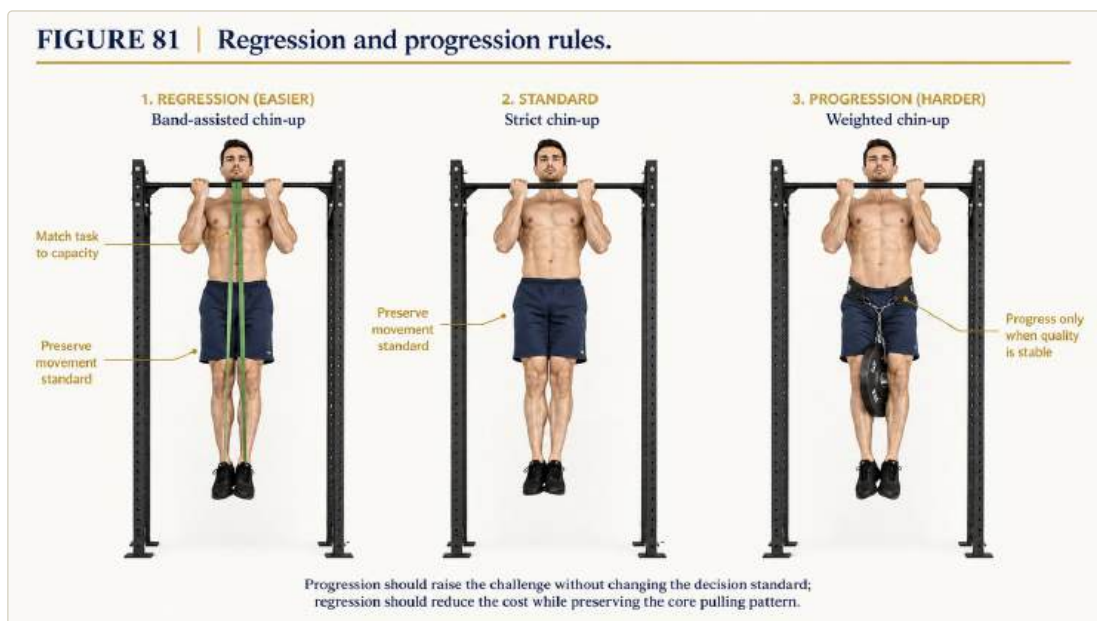
One variable, response-led. Regress at the failure point when the standard slips; progress a defined step when it holds — never both at once.



Flowchart 81.1. Regression/progression on the standard-and-retest rule.

GREEN Standard + recovery stable → progress one variable.	AMBER Quality slipping → hold or regress; do not add load.	RED Symptoms or recovery worsening → reduce dose; reassess.
---	--	---

FIGURE 81



Show a targeted regression against a single-variable progression.

MMSx coaching translation: move one lever, then look. The athlete's response, not the calendar, sets the next step.

CHAPTER 82 · PART VII — CORRECTION

Retesting after corrective work

A correction is a hypothesis until it is retested. After applying a cue or regression, the coach retests the *same* standard — the failure angle, the range, the body line — to confirm the fault actually moved. Velocity or hold-time measures make the retest objective, and a fault that has not moved means the cause was misdiagnosed, not that the athlete needs more effort (Sánchez-Medina & González-Badillo, 2011).

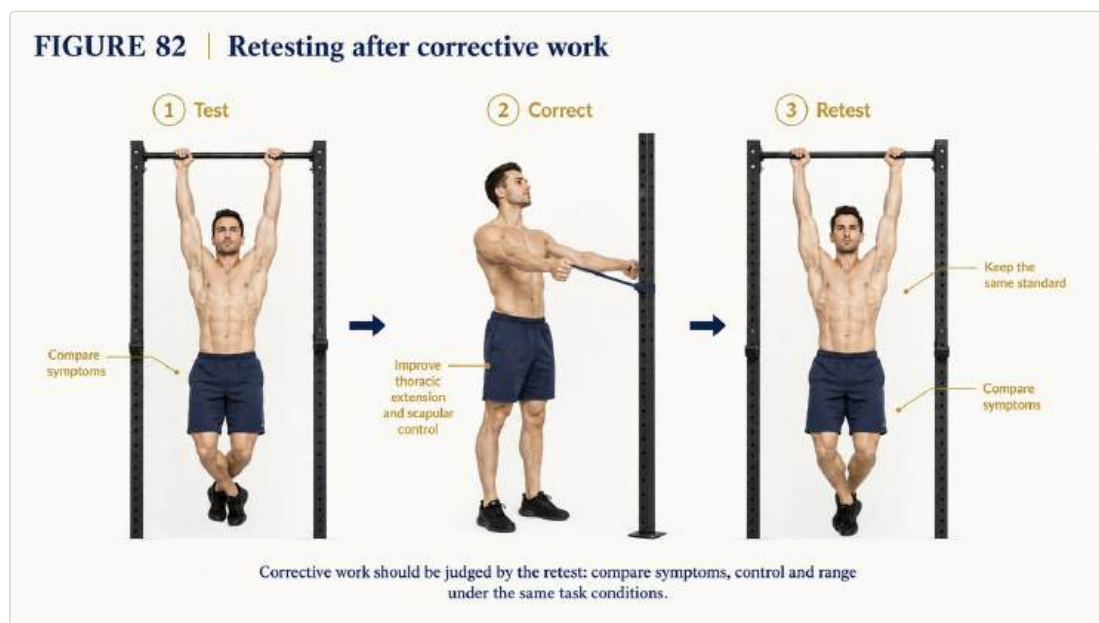
KEY IDEA

Every correction is a hypothesis; the retest is the experiment. If the fault did not move, change the diagnosis, not the volume.



Flowchart 82.1. The correction-retest loop.

FIGURE 82



Show the same standard before and after, with the objective retest.

MMSx coaching translation: always retest the exact thing you tried to fix. No movement in the fault means the diagnosis, not the athlete, was wrong.

CHAPTER 83 · PART VII — COACHING

Coaching beginners without over-cueing

Beginners improve fastest with fewer, clearer instructions. A flood of cues overloads attention and slows learning; a single external-focus cue lets the athlete self-organise (Wulf, 2013; Benjaminse & Otten, 2011). The coach's discipline is to identify the one fault that matters most and address only that, letting the others resolve or wait.

KEY IDEA

Say less to teach more. One clear external cue outperforms a stack of corrections for a beginner.

Figure 83.1 · Learning quality vs number of simultaneous cues (illustrative)**SCHEMATIC**

Learning quality falls as simultaneous cues rise; one well-chosen cue is the sweet spot for beginners.

FIGURE 83.2**FIGURE 83 | Coaching beginners without over-cueing**

Beginners improve fastest when the coach simplifies the task and prioritises a few high-value cues rather than excessive verbal noise.

Show restraint: one cue, then observe.

MMSx coaching translation: pick the one fault that matters and cue only that. The rest often fixes itself.

CHAPTER 84 · PART VII — COACHING

Coaching advanced athletes without breaking style

Advanced athletes have often optimised their technique to their own anthropometry and tolerance (Chapter 36), so aggressive "correction" can make them worse. The coaching task shifts from fixing to refining: distinguish a genuine mechanical leak from a harmless individual style, and intervene only where a change improves output or reduces risk without disturbing a working pattern.

KEY IDEA

With advanced athletes, refine — don't rebuild. Change only what is genuinely costing performance or tissue; leave individual style that works alone.

Table 84.1. Style vs fault in the advanced athlete

Observation	Read as	Action
Idiosyncratic but efficient path	Individual style.	Leave it; monitor.
Consistent force leak or symptom	Genuine fault.	Targeted, minimal correction.
Fault only under fatigue/heavy load	Capacity limit, not technique.	Manage dose; build capacity.

Part VIII now turns to pain, injury and return-to-load — how to manage the athlete when tissue tolerance, not technique, is the limiting factor.

FIGURE 84



Help the coach tell harmless style from a real fault.

MMSx coaching translation: if it works and doesn't hurt, don't fix it. Refine the leak, respect the style.

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PART VIII

Chapters 85 – 96

Pain, Injury and Return-to-Load

When tissue tolerance, not technique, is the limiter, the decision changes. This part reads pulling through a load-versus-capacity lens — recognising common pain patterns, distinguishing adaptation from irritation, screening for the signs that demand referral, and rebuilding load and confidence on a monitored, graded ladder. It is educational, and never a substitute for individual clinical assessment.

85 • Load-capacity

86 • Front shoulder

87 • Cuff fatigue

88 • Elbow

89 • Wrist/hand

90 • Neck/trap

91 • Anterior shoulder

92 • Tendon

93 • Referral

94 • Return ladder

95 • Monitoring

96 • Shoulder-friendly

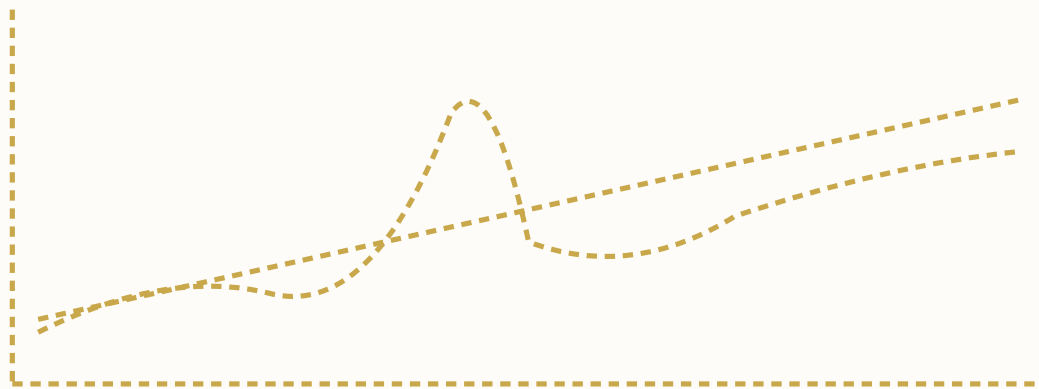
CHAPTER 85 · PART VIII — PAIN & RETURN-TO-LOAD

Load-capacity model for vertical pulling

Most training-related pain in pulling is a mismatch between the load applied and the capacity of the tissue to tolerate it. Capacity is not fixed: it rises with appropriate, graded exposure and falls with fatigue, illness or a lay-off. Problems arise when load spikes above capacity — a sudden jump in volume, weight or frequency — rather than from pulling itself (Gabbett, 2016; Soligard et al., 2016). The whole of Part VIII is an application of this one model.

KEY IDEA

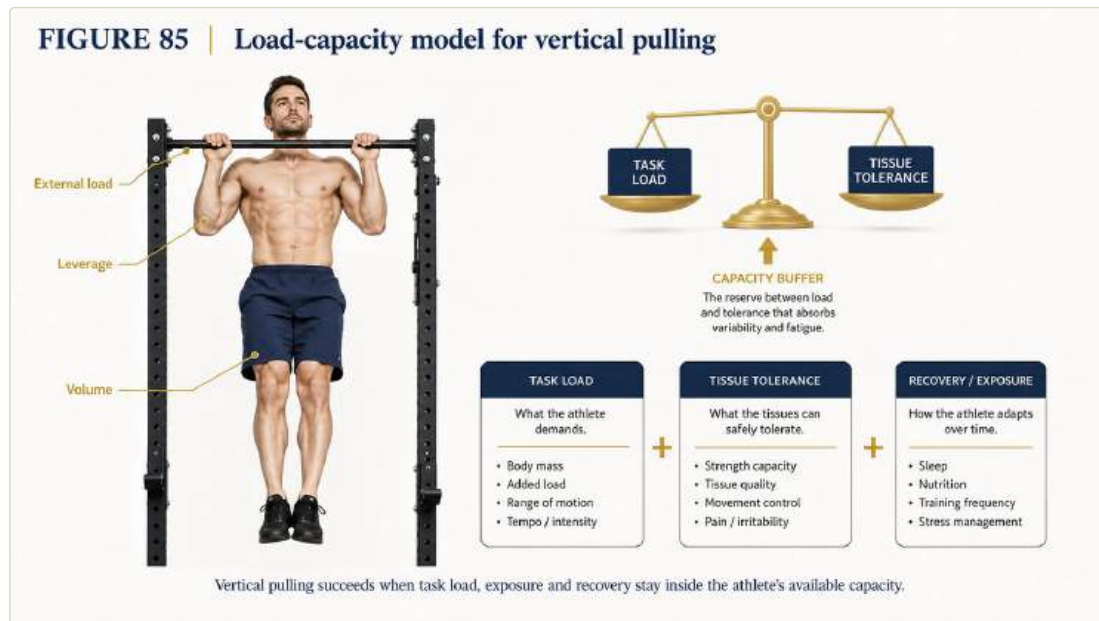
Pain is usually a load-versus-capacity problem, not a "bad exercise" problem. Build capacity gradually and avoid spikes, and most pulling pain is preventable.

Figure 85.1 · Load vs tissue capacity over time**SCHEMATIC**

Capacity rises with graded exposure; symptoms typically follow a load spike above the current capacity line, not steady training.

EVIDENCE NOTE

Rapid increases in training load are associated with greater injury risk, whereas well-developed capacity is protective — "train smarter and harder", not one or the other (Gabbett, 2016; Soligard et al., 2016).

FIGURE 85.2

Show controlled progression against a provocative spike.

MMSx coaching translation: don't ask whether pulling is "safe" — ask whether today's load fits today's capacity. Build the line up; keep the load under it.

CHAPTER 86 · PART VIII — PAIN & RETURN-TO-LOAD

Front shoulder pain patterns

Anterior shoulder pain in pulling often relates to a loss of humeral-head centration under load — the cuff and scapular controllers failing to keep the joint seated while the powerful prime movers pull (Chapters 28 and 44; Lewis, 2016). It is commonly load- and fatigue-dependent, and frequently settles with a change of grip, a shorter range, or reduced volume — but a persistent, worsening or night-pain presentation is a referral.

KEY IDEA

Front-of-shoulder pain in pulling is often a centration-and-load story. Modify grip, range and volume first; refer what does not settle.

GREEN No pain, controlled range → load normally.	AMBER Mild, settling niggle → neutral grip, shorter range, less volume.	RED Night/constant pain, weakness, worsening → refer.
--	---	---

Table 86.1. Front shoulder pattern

Feature	Likely driver	First management
Pinch at top / painful arc	Loss of centration under load.	Neutral grip; shorten range; set the scapula.
Worse with fatigue/volume	Capacity exceeded late in session.	Reduce volume; end sets earlier.
Provoked by passive hang	End-range irritation.	Active set; avoid long passive hangs.

FIGURE 86



Show the centration difference associated with the pattern.

MMSx coaching translation: for a cranky front shoulder, go neutral, shorten the range and set the blade — and refer anything that won't settle.

CHAPTER 87 · PART VIII — PAIN & RETURN-TO-LOAD

Rotator cuff tolerance and fatigue

The cuff's centration job (Chapter 44) is fatigue-sensitive: as it tires late in a session or across a heavy week, centration slips and the shoulder becomes vulnerable even though the prime movers are still strong. Cuff tolerance is therefore best protected by managing total load and fatigue, not by isolated "cuff exercises" alone (Lewis, 2016; Desmeules et al., 2025).

KEY IDEA

The cuff fails quietly under fatigue. Protect it by managing session and weekly load, so centration holds when it matters most.

Figure 87.1 · Cuff centration capacity vs accumulated fatigue

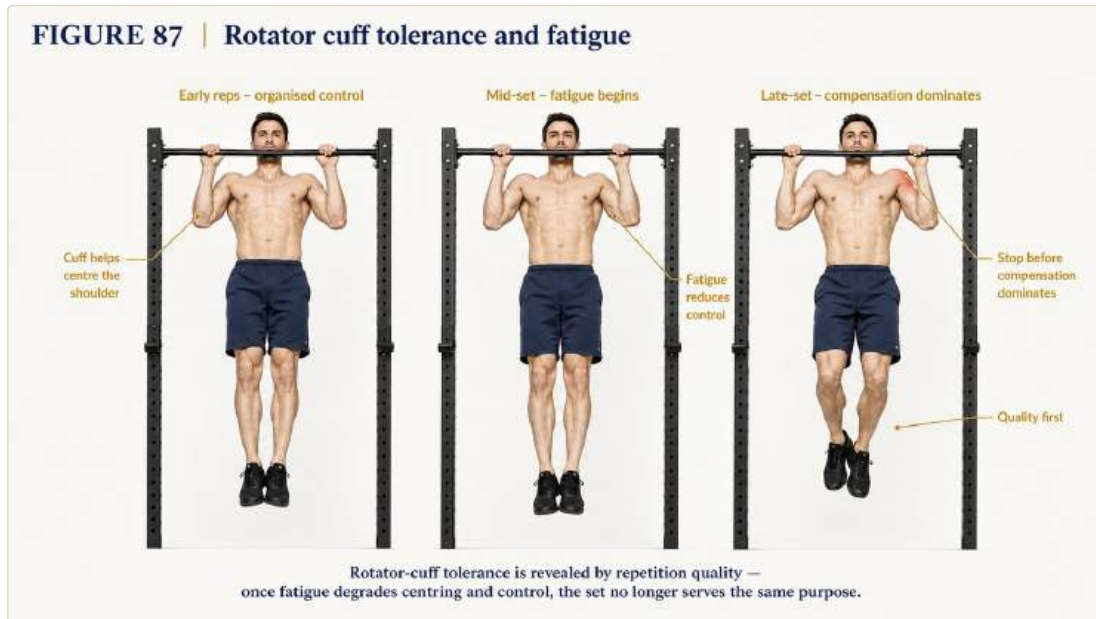
SCHEMATIC



Centration capacity declines with fatigue; the last sets of a heavy week are where the shoulder is most exposed.

CREDIBILITY & CAUTION

Progressive weakness, a painful give-way or symptoms that persist beyond expected soreness warrant evaluation. Fatigue-related niggles differ from a structural problem — when unsure, refer.

FIGURE 87

Contrast a fresh, centred shoulder with a fatigued, drifting one.

MMSx coaching translation: most cuff problems are dose problems. Manage fatigue and the cuff usually looks after itself.

CHAPTER 88 · PART VIII — PAIN & RETURN-TO-LOAD

Medial and lateral elbow pain patterns

Elbow pain in pulling tracks the flexor and forearm load of Chapters 27 and 41. Medial (inner) elbow pain commonly relates to the flexor-pronator load, often in supinated, high-volume chin-up work; lateral (outer) elbow pain relates to the extensor/forearm side and grip demand. Both are usually load-sensitive and respond to grip change, reduced volume and graded loading rather than to stopping altogether.

KEY IDEA

Elbow pain follows forearm and flexor load. Medial with supinated volume, lateral with grip demand — modify grip and dose before abandoning the pull.

Table 88.1. Elbow pain patterns

Site	Likely driver	First management
Medial (inner)	Flexor-pronator load; supinated volume.	Reduce supinated volume; neutral/pronated; graded loading.
Lateral (outer)	Extensor/forearm and grip demand.	Reduce grip demand; thinner bar; manage volume.
Either, load-linked	Capacity exceeded.	Graded reintroduction under symptom monitoring.

CREDIBILITY & CAUTION

Sudden painful give-way, marked swelling, or a sense of tearing is not a load-tolerance niggles — refer.

FIGURE 88



Map the two sites to their mechanical drivers.

MMSx coaching translation: sore inner elbow? Cut supinated volume. Sore outer elbow? Ease the grip demand. Then rebuild gradually.

CHAPTER 89 · PART VIII — PAIN & RETURN-TO-LOAD

Wrist and hand irritation

Wrist and hand irritation usually comes from set-up, not from pulling volume alone: an unstacked wrist, an extreme grip width, or a fixed straight bar that forces the wrist into deviation (Chapter 26). Most cases settle with a stacked wrist, a comfortable grip orientation, or rotating handles that let the forearm find its own position.

KEY IDEA

Wrist pain is usually a set-up problem. Stack the wrist and free the grip orientation before blaming volume.

Table 89.1. Wrist and hand irritation

Feature	Likely driver	First management
Pain with fixed straight bar	Forced wrist deviation.	Rotating handles; neutral grip.
Collapsed wrist under load	Unstacked transfer.	Cue a stacked wrist; check bar thickness.
Callus tears / skin	Friction and hand care.	Hand care; chalk management; volume.

FIGURE 89



Show the wrist set-up fixes.

MMSx coaching translation: sore wrists usually mean a bar or set-up problem. Stack the wrist, free the rotation, and it often resolves.

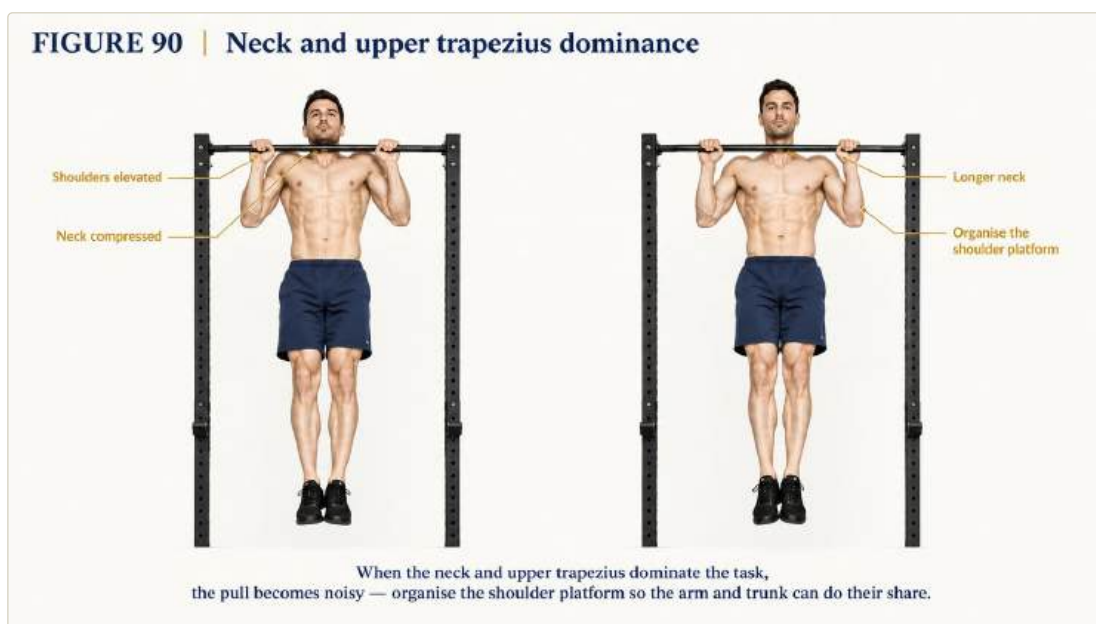
CHAPTER 90 · PART VIII — PAIN & RETURN-TO-LOAD

Neck and upper-trapezius dominance

When the lower trapezius and scapular depressors under-work, the upper trapezius takes over, producing a shrug, neck compression and a familiar band of neck-shoulder tightness (Chapters 29 and 42). The correction is not to stretch the neck but to restore scapular depression, so the platform is set by the right muscles.

KEY IDEA

Upper-trap dominance is a scapular-control problem wearing a neck disguise. Restore depression; the neck settles.

FIGURE 90

Contrast the shrug pattern with a set platform.

EVIDENCE NOTE

Restoring lower-trapezius and serratus contribution reduces upper-trapezius dominance and improves scapular control (Ekstrom et al., 2003; Cools et al., 2014).

MMSx coaching translation: if the neck lights up, coach "shoulders down" and scapular pull-ups — don't chase the neck itself.

CHAPTER 91 · PART VIII — PAIN & RETURN-TO-LOAD

Pectoral and anterior-shoulder sensitivity

Because the sternal pectoralis contributes to the early pull from an overhead position (Chapter 46), a sensitive anterior structure can be provoked by very wide grips or aggressive stretched positions at the bottom. Narrowing the grip slightly, controlling the bottom range and avoiding ballistic bottoming-out usually reduces the provocation while keeping the pull.

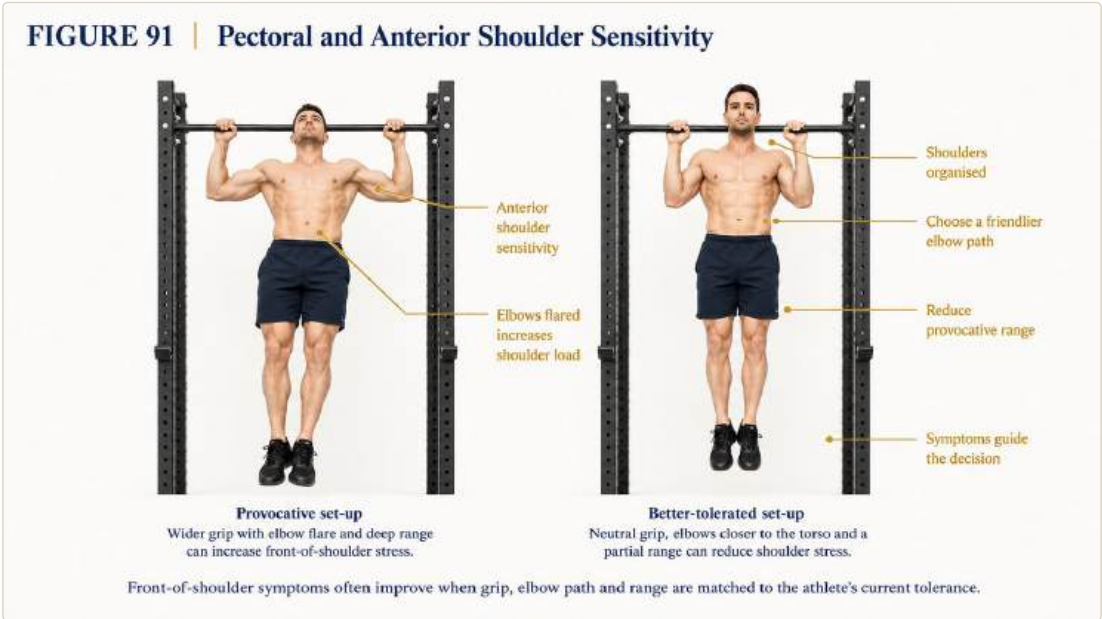
KEY IDEA

Anterior sensitivity is often a bottom-range and width issue. Narrow slightly and control the bottom before removing the exercise.

Table 91.1. Anterior-shoulder sensitivity

Provoker	Mechanism	First management
Very wide grip	Greater anterior stretch/load.	Narrow the grip slightly.
Ballistic bottom	Abrupt end-range load.	Control the last third of descent.
Full dead-hang stretch	End-range provocation.	Active set; limit bottom range temporarily.

FIGURE 91



Show the width/bottom-range adjustments.

MMSx coaching translation: anterior twinge? Narrow a touch and own the bottom of the descent — usually enough to keep pulling.

CHAPTER 92 · PART VIII — PAIN & RETURN-TO-LOAD

Tendon adaptation and irritability

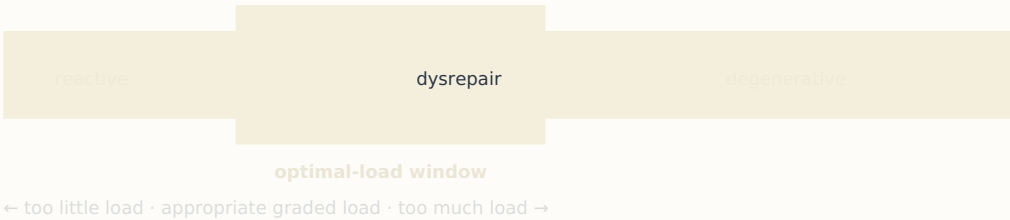
Tendons adapt to load, but they adapt slowly and dislike sudden change. A useful model places tendon states on a continuum from reactive, through dysrepair, to degenerative — with load acting as both the provocateur of a reactive flare and, dosed correctly, the primary stimulus for adaptation (Cook & Purdam, 2009). The practical handle is *irritability*: how easily symptoms flare and how long they take to settle governs how much load the tendon can take right now (Silbernagel et al., 2020).

KEY IDEA

Load is both the problem and the cure for a tendon. Dose it by irritability — quiet, slow-to-flare tendons take more; reactive, quick-to-flare tendons take less.

Figure 92.1 · The tendon continuum and the load window

SCHEMATIC



Tendon states form a continuum; appropriate graded load sits in a window between too little (no adaptation) and too much (flare). After Cook & Purdam (2009).

GREEN

Minimal, quick-settling symptoms → progress load gradually.

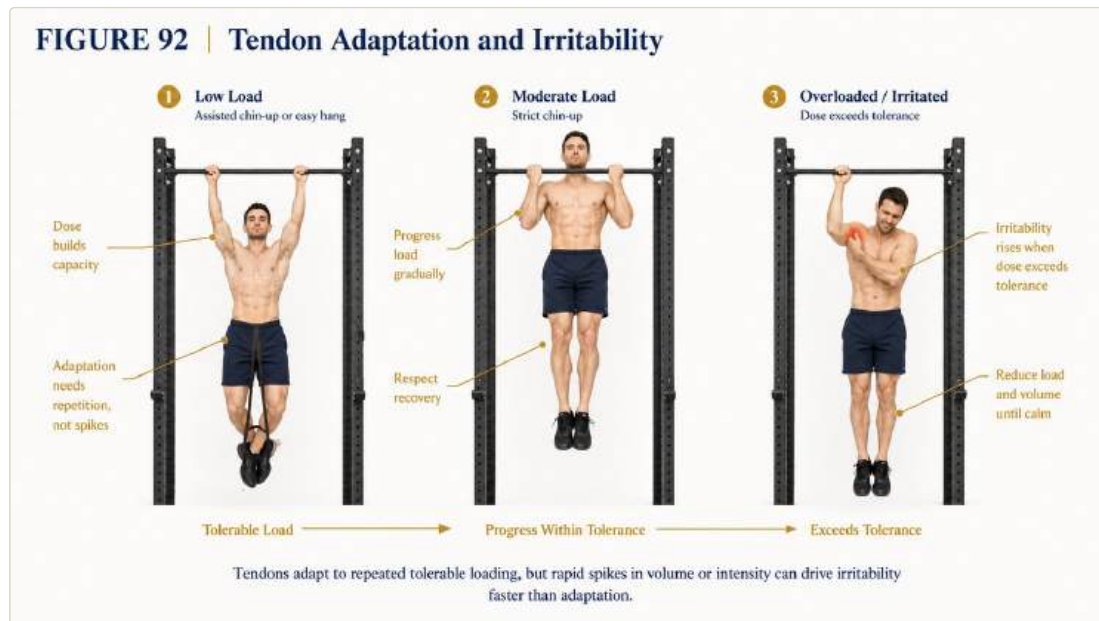
AMBER

Flares easily, settles within 24 h → hold load; monitor.

RED

High irritability, slow to settle, worsening → reduce load; assess/ refer.

FIGURE 92.2



Show load kept within the adaptive window.

MMSx coaching translation: tendons need load to heal, but the right dose. Read irritability, stay in the window, and change load slowly.

CHAPTER 93 · PART VIII — PAIN & RETURN-TO-LOAD

Acute warning signs and referral logic

Most pulling pain is load-related and manageable, but a defined set of signs is not — and recognising them is a duty of care, not an optional extra. Chest pain or breathlessness, neurological signs, acute trauma, a sudden painful give-way, progressive weakness, night or unremitting pain, and post-surgical restriction all move the decision out of training and into referral (Lafrance et al., 2022; Desmeules et al., 2025).

KEY IDEA

Know the signs that end the training conversation. When a red flag appears, the correct next step is referral, every time.

Chest pain /
breathlessness

Neurological signs

Give-way /
progressive
weakness

Night / unremitting
pain

Flowchart 93.1. Any red flag → stop and refer. Do not load, do not "monitor".

CREDIBILITY & CAUTION

This reference is educational and cannot diagnose. Chest pain and breathlessness may be medical emergencies. When any red flag is present or symptoms are unexplained, seek qualified evaluation before any further loading.

FIGURE 93



Design as a high-visibility referral reference.

MMSx coaching translation: some signs are not yours to coach through. Learn the red flags cold, and refer without hesitation.

CHAPTER 94 · PART VIII — PAIN & RETURN-TO-LOAD

Return-to-pull ladder after symptoms

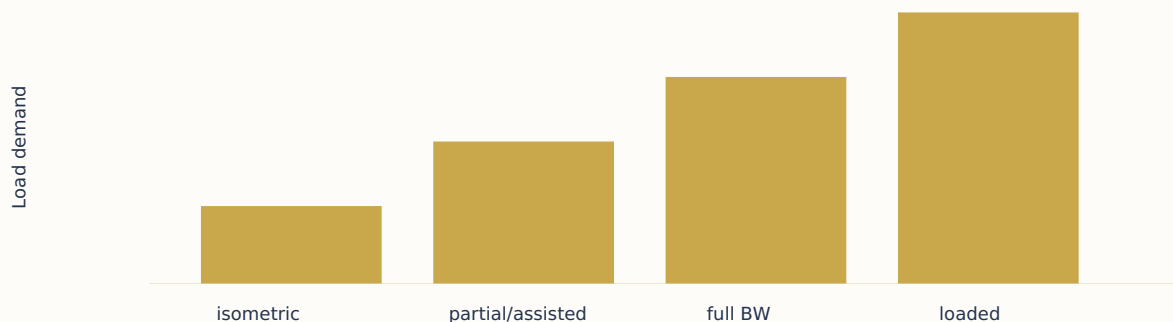
Returning to pulling after a settled episode is a graded ladder, not a single test. It typically climbs from isometric holds at tolerated angles, through partial-range and assisted reps, to full body-weight reps and then added load — advancing only when each rung is tolerated within the monitoring rule of Chapter 95 (Silbernagel et al., 2020; ACSM, 2009). The ladder rebuilds capacity in the order the tissue can accept it.

KEY IDEA

Return in rungs, not in a leap. Isometric → partial/assisted → full → loaded, advancing only when the current rung is tolerated.

Figure 94.1 · Return-to-pull ladder (representative)

SCHEMATIC



Each rung is cleared under the pain-monitoring rule before the next is added. Timescale individual.

FIGURE 94.2

FIGURE 94 | Return-to-Pull Ladder After Symptoms



After symptoms settle, return to pulling by rebuilding the same mechanical problem from low cost to high cost.

Show the graded return positions.

MMSx coaching translation: rebuild in order — hold, then partial, then full, then loaded — and only climb when the rung below is calm.

CHAPTER 95 · PART VIII — PAIN & RETURN-TO-LOAD

Pain monitoring and confidence rebuilding

Return-to-load needs a rule for interpreting pain, because zero pain is not always the right target and any pain is not always a warning. A widely used monitoring model permits low, acceptable symptoms during and after loading provided they settle within about twenty-four hours and do not worsen session to session; symptoms that climb or linger mean the last step was too big (Silbernagel et al., 2020). Alongside the tissue, confidence must be rebuilt — graded success restores trust in the shoulder as much as it restores capacity (Moseley & Butler, 2015).

KEY IDEA

Monitor pain by the 24-hour response, not by zero. Low symptoms that settle and don't progress are acceptable; symptoms that climb are the signal to step back.

GREEN

Low symptoms, settle within 24 h, not worsening → continue/progress.

AMBER

Moderate or slow-settling → hold the rung; do not progress.

RED

Climbing session to session, night pain, new signs → step back; reassess/refer.

CREDIBILITY & CAUTION

Monitoring models support decision-making but do not replace individual clinical judgement. Escalating or unexplained symptoms warrant professional evaluation.

FIGURE 95



Show the settle-versus-escalate distinction over 24 hours.

MMSx coaching translation: ask "is it settling within a day and not getting worse?" If yes, carry on; if no, step back — and rebuild confidence with wins the athlete can feel.

CHAPTER 96 · PART VIII — PAIN & RETURN-TO-LOAD

Shoulder-friendly pulling is a decision, not a single grip

There is no universally "shoulder-safe" grip; there is a decision that makes pulling friendly for a given shoulder on a given day. That decision combines grip, range, tempo, volume and the load-capacity logic of this part — routing peak demand to tolerant tissue, staying inside the capacity line, and monitoring the response (Chapters 5, 16, 85 and 95; Lewis, 2016). "Shoulder-friendly" is the whole decision science applied to a sensitive joint.

KEY IDEA

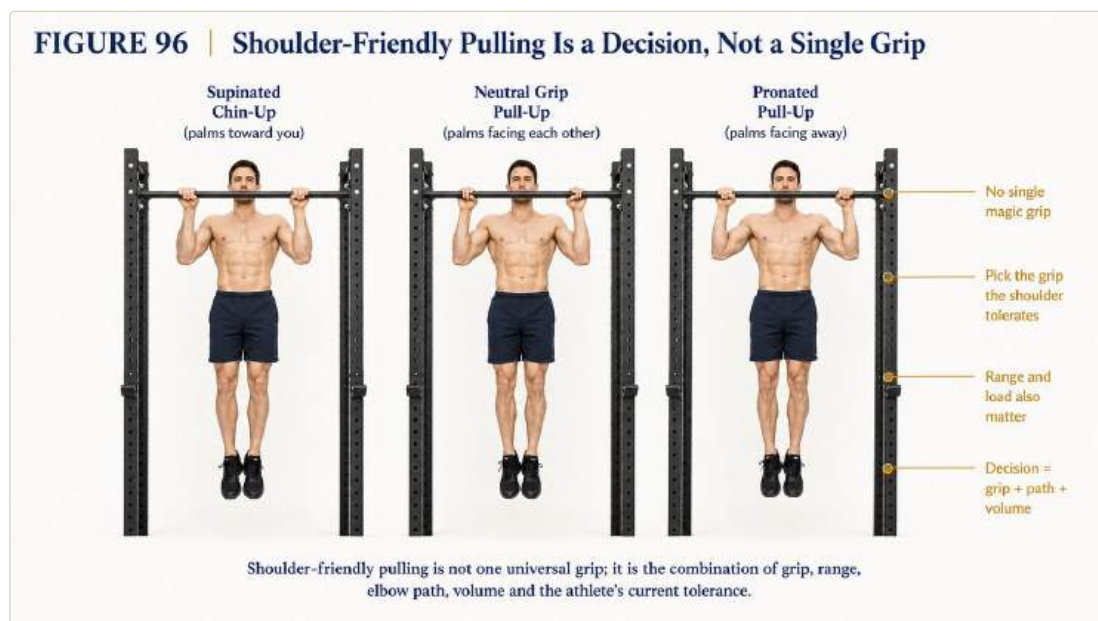
Shoulder-friendly is a decision, not a grip. Assemble grip, range, tempo, volume and dose to fit the shoulder in front of you — and re-decide as it changes.



Flowchart 96.1. Shoulder-friendly pulling as an assembled, monitored decision.

Part IX now turns to programming by goal and population — assembling these decisions into complete plans for different athletes and aims.

FIGURE 96



Show the assembled decision rather than a single "safe" grip.

MMSx coaching translation: stop hunting the one safe grip. Assemble the decision to the shoulder, keep it under capacity, and watch the 24-hour response.

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PART IX

Chapters 97 – 108

Programming by Goal and Population

Every decision science in this book now becomes a plan. This part assembles grip, phase, progression and load-management logic into complete programmes — by goal, from first rep to power, and by population, from climbers to masters athletes — and shows where the vertical pull sits inside a whole training week. The plans are templates to individualise, never prescriptions to obey.

97 • Principles

98 • Beginner 12-wk

99 • Intermediate

100 • Weighted

101 • Hypertrophy

102 • Power

103 • Climbers

104 • Field sport

105 • Combat

106 • Masters

107 • General

108 • Integration

CHAPTER 97 · PART IX — PROGRAMMING

Principles of weekly programming

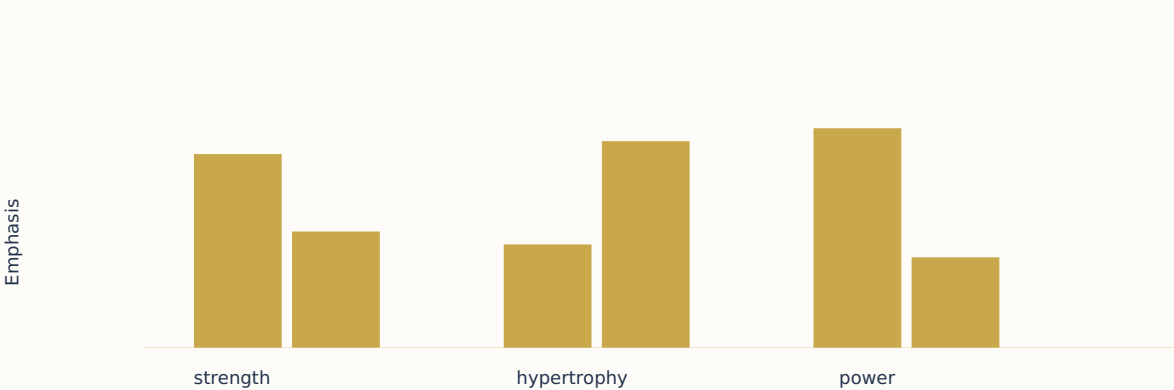
A programme is the deliberate arrangement of frequency, volume, intensity and recovery so that capacity rises without the load spikes of Chapter 85. The vertical pull is programmed like any strength quality: enough frequency to practise, enough volume to adapt, enough intensity to drive the target, and enough recovery to absorb it (ACSM, 2009; Haff & Triplett, 2016). The goal decides which of these levers leads.

KEY IDEA

Programming is arranging four levers — frequency, volume, intensity, recovery — around one goal. The goal sets which lever leads; the rest support it.

Figure 97.1 · The four programming levers by goal emphasis (illustrative)

SCHEMATIC

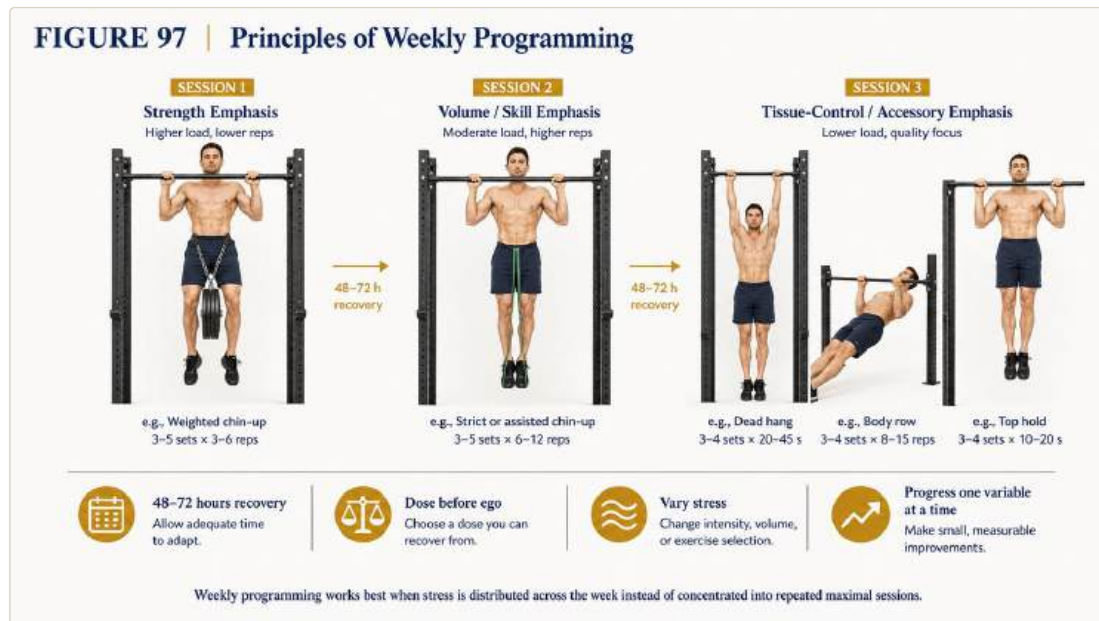


Navy = intensity emphasis, gold = volume emphasis. Strength leads with intensity, hypertrophy with volume, power with intensity at speed. Illustrative.

Table 97.1. Programming levers by goal

Goal	Frequency	Volume	Intensity	Lead lever
Strength	Moderate-high	Moderate	High	Intensity.
Hypertrophy	Moderate	High	Moderate	Volume.
Power	Moderate	Low-moderate	High at speed	Intent/velocity.
First rep	High	Low	Sub-max	Frequency (skill).

FIGURE 97



Principles of weekly programming.

MMSx coaching translation: pick the goal, pick the lead lever, and let the other three serve it. Don't chase all four at once.

CHAPTER 98 · PART IX — PROGRAMMING

Beginner twelve-week plan

The beginner plan turns the on-ramp and first-rep rungs of Part VI into a concrete twelve weeks: a foundation block, a first-rep block and a consolidation block, with frequency high and load sub-maximal so the pattern is practised often and fresh (Chapter 8; ACSM, 2009). Progress is gated by the standard-and-retest rule, not by the calendar.

KEY IDEA

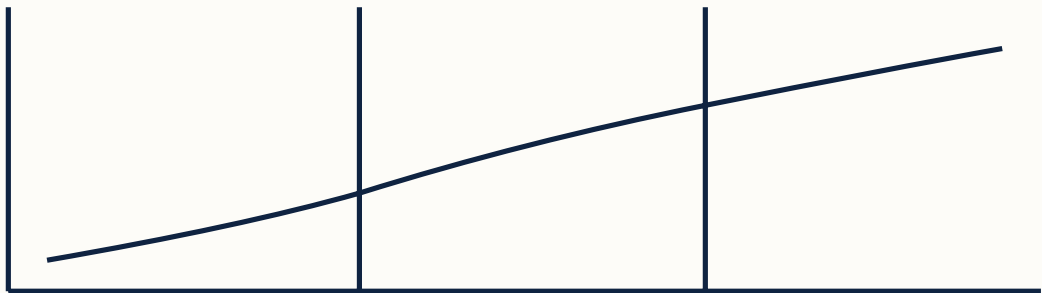
Twelve weeks, three blocks, one destination: a clean first rep and a little repeatable volume. Frequency and freshness, not grinding, get the beginner there.

Table 98.1. Beginner twelve-week template

Block	Weeks	Focus	Sessions/wk	Exit standard
Foundation	1-4	Hangs, scapular pull-ups, rows	2-3	Active hang; clean scapular reps
First rep	5-8	Assisted + eccentric + isometric	3	One strict full-range rep
Consolidate	9-12	Frequent low-rep quality sets	3	Repeatable 3-5 rep sets

Figure 98.1 · Beginner capacity across twelve weeks (illustrative)

SCHEMATIC



Capacity climbs steadily across the three blocks; the curve, not the week number, sets progression.

FIGURE 98.2

Show the three block milestones on one athlete.

MMSx coaching translation: give the beginner the twelve-week map but move when the standard says so — some clear a block early, some need an extra week.

CHAPTER 99 · PART IX — PROGRAMMING

Intermediate strength block

Once multi-rep sets are secure, the intermediate block shifts the lead lever to intensity: lower reps, higher effort, and gradually rising load, arranged so hard and lighter sessions alternate to manage fatigue (Rhea et al., 2003; Sánchez-Medina & González-Badillo, 2011). Velocity or reps-in-reserve can cap each set before mechanics degrade.

KEY IDEA

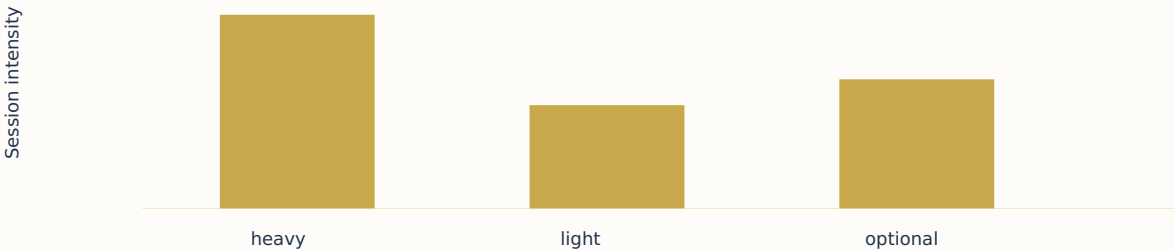
Intermediate strength is intensity-led and fatigue-managed. Push the hard days, ease the light days, and cap sets before form fails.

Table 99.1. Intermediate strength block (six weeks, representative)

Day	Emphasis	Sets × reps	Effort	Note
Heavy	Low-rep strength	5 × 3–4	~2 RIR	Strict; full range
Light	Quality volume	4 × 6	~3–4 RIR	Technique focus
Optional	Skill/accessory	3 × 6–8	submax	Grip / scapular work

Figure 99.1 · Undulating intensity across the week (illustrative)

SCHEMATIC



Alternating heavy and lighter sessions manages fatigue while intensity trends up week to week.

FIGURE 99**FIGURE 99 | Intermediate Strength Block**

Intermediate strength blocks combine heavier loading with enough volume and accessory support to keep the vertical-pull system progressing.

Show the quality standard the block protects.

MMSx coaching translation: at intermediate, alternate heavy and light and stop each set with a rep or two in reserve. Quality is the point, not maximal grinding.

CHAPTER 100 · PART IX — PROGRAMMING

Advanced weighted chin-up block

The advanced block adds external load on a secure strict base (Chapter 70), progressing weight in small steps and using heavier top sets with lighter back-off volume. Maximal strength underpins nearly every other quality, so a well-run weighted block raises the ceiling for power, hypertrophy and endurance alike (Suchomel et al., 2016; Zatsiorsky & Kraemer, 2006).

KEY IDEA

Weighted work raises the whole ceiling. Small load steps, heavy top sets, lighter back-offs — strength built here carries into every other goal.

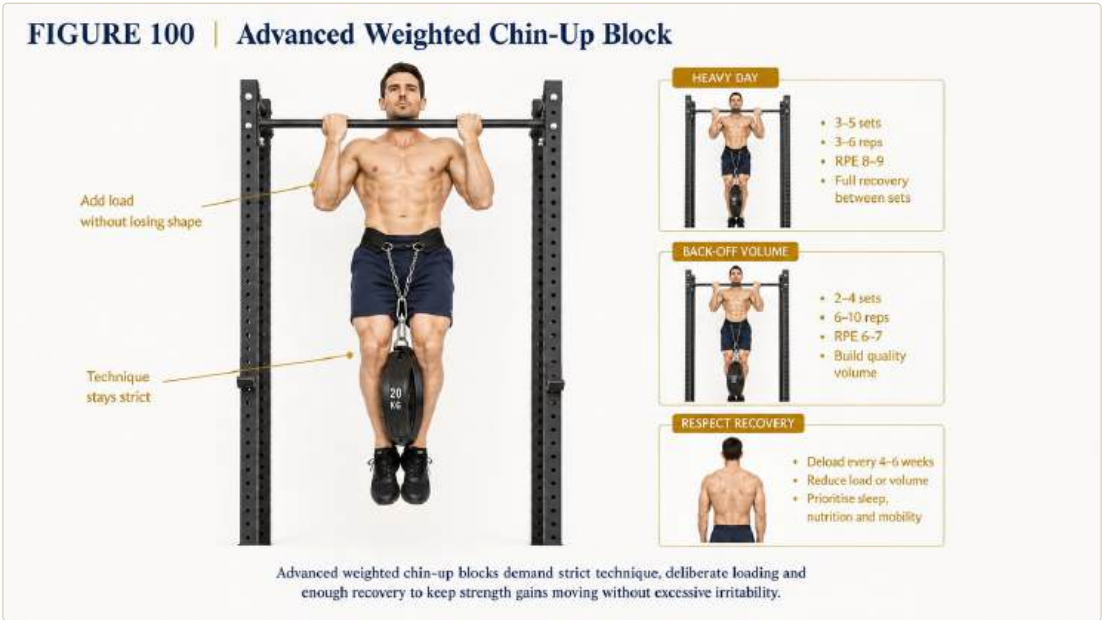
Table 100.1. Advanced weighted block (representative)

Component	Sets × reps	Load	Progress by
Top sets	3-4 × 3-5	Heavy added weight	+small increment when standard holds
Back-off	2-3 × 6-8	Reduced load	Add reps, then load
Accessory	2-3 × 8-10	Body weight	Volume / range work

CREDIBILITY & CAUTION

Added load magnifies any centration or elbow-tolerance issue. Progress only on a pain-free strict base, and apply the load-capacity and monitoring logic of Part VIII.

FIGURE 100



Show the strict standard maintained under added weight.

MMSx coaching translation: heavy top sets, easier back-offs, tiny weight jumps. Build the ceiling and everything else rises with it.

CHAPTER 101 · PART IX — PROGRAMMING

Hypertrophy block

When size is the goal, the lead lever is volume (Chapter 69): more weekly quality sets taken close to failure through full range, with moderate loads and controlled tempo (Schoenfeld et al., 2017; Grgic et al., 2018). Grip and width choices bias which pulling muscles grow, and weekly volume is added to the edge of what recovery supports.

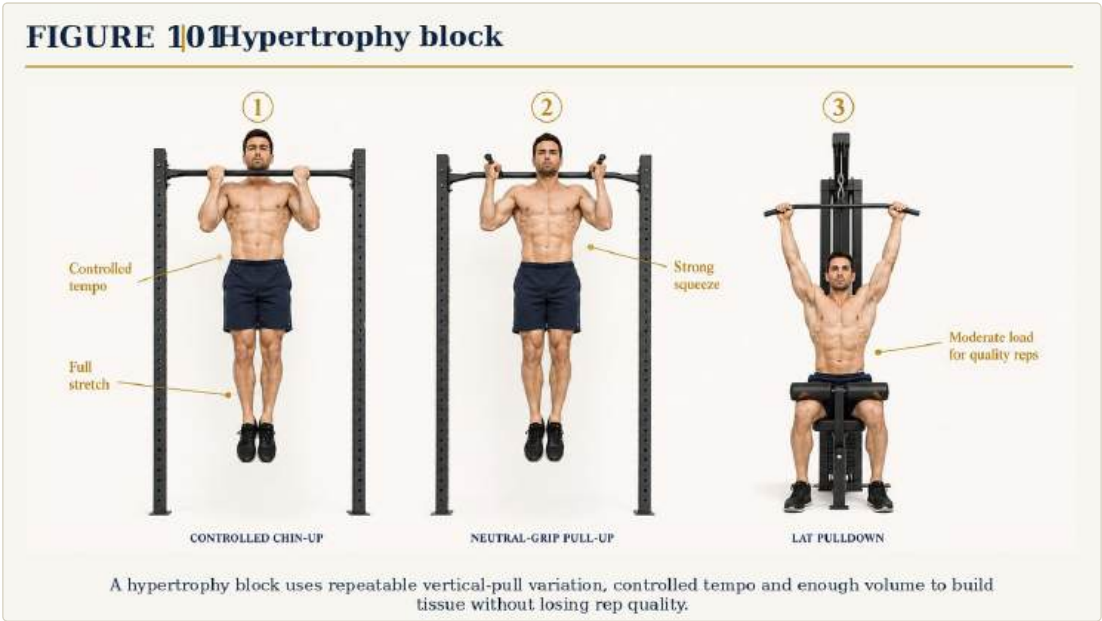
KEY IDEA

For size, volume leads. Add weekly quality sets near failure through full range, up to the limit recovery allows.

Table 101.1. Hypertrophy block (representative)

Component	Sets × reps	Effort	Emphasis
Primary pull	4 × 8–12	1–2 RIR	Full-range latissimus loading
Grip variant	3 × 10–12	1–2 RIR	Bias elbow flexors or width
Accessory rows	3 × 10–15	1–2 RIR	Volume; scapular control

FIGURE 101



Show the full-range quality rep that maximises growth stimulus.

MMSx coaching translation: for size, do more good sets through full range, a rep or two from failure — and let recovery cap the total.

CHAPTER 102 · PART IX — PROGRAMMING

Power and athletic transfer

Power is force expressed quickly, so power-focused pulling trains intent and velocity: explosive concentrics from a strict base, sometimes assisted or with reduced load to keep bar speed high (Cormie et al., 2011; Suchomel et al., 2016). The force-velocity relationship means an athlete can be trained toward the force end (heavy, slow) or the velocity end (light, fast); athletic transfer usually needs both across a plan.

KEY IDEA

Power is strength expressed fast. Train intent and velocity from a strong base, and move along the force-velocity curve according to the sport's demand.

Figure 102.1 · The force-velocity relationship and training zones

SCHEMATIC



Higher force comes at lower velocity and vice versa; training targets a zone of this curve to suit the sport.

FIGURE 102

FIGURE 102 Power and athletic transfer



Power transfer should be trained only after the athlete can keep strict pulling mechanics under speed, load or density pressure.

Show the explosive-intent rep used for power.

MMSx coaching translation: for power, pull with intent to move fast from a strong base — and pick the force or velocity end to match the sport.

CHAPTER 103 · PART IX — POPULATION

Climbers and grip-demand athletes

For climbers and grip-dependent athletes, the grip is the sport, so programming emphasises grip endurance and varied holds while managing the elbow and finger-tissue load that this population is prone to overreaching (Chapters 25, 41 and 88). Vertical pulling is trained with grip variation and careful volume progression rather than maximal crush every session.

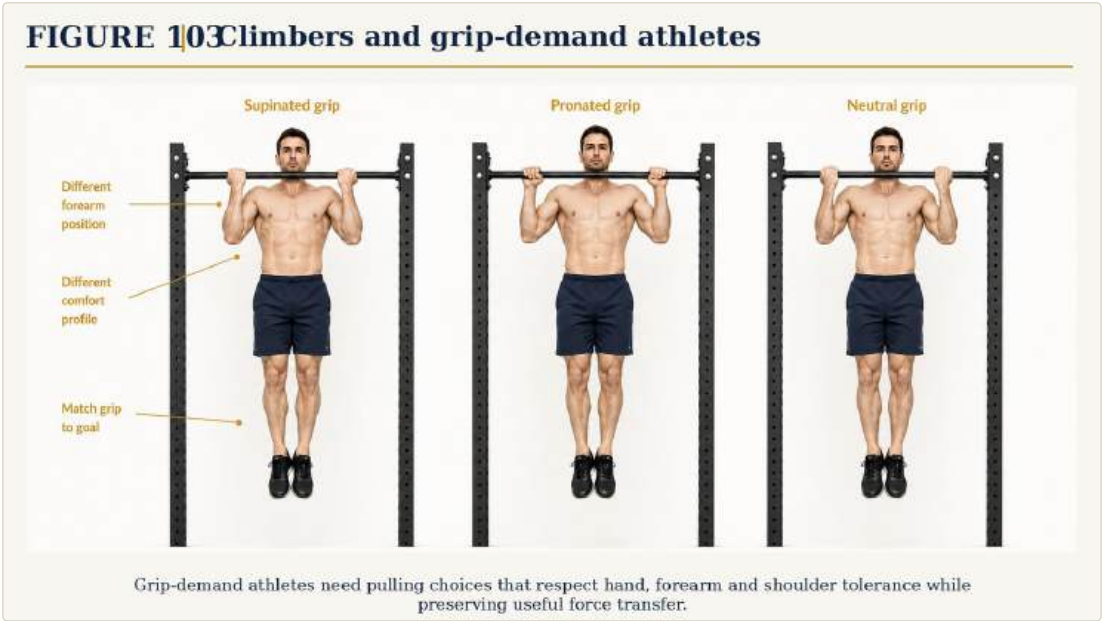
KEY IDEA

When the grip is the sport, programme it as the priority and its tissue as the risk. Vary holds; progress grip volume conservatively.

Table 103.1. Grip-demand priorities

Priority	Method	Watch
Grip endurance	Varied holds, hangs, thick bars.	Finger/elbow tissue load.
Pull strength	Strict and weighted pulling.	Recovery around climbing volume.
Tissue tolerance	Gradual grip-volume rises.	Medial/lateral elbow symptoms.

FIGURE 103



Show the varied holds that build grip without overreaching one tissue.

MMSx coaching translation: for climbers, train the grip hard but progress it slowly, and watch the elbows — that is where this population overreaches.

CHAPTER 104 · PART IX — POPULATION

Field-sport athletes

Field-sport athletes need the vertical pull as one supporting quality inside a large training load, so it is programmed for efficient strength and robustness rather than maximal pulling numbers. Volume is kept compatible with sprinting, contact and skill work, and the pull earns its place by building a resilient upper body without stealing recovery from the sport (Suchomel et al., 2016; Soligard et al., 2016).

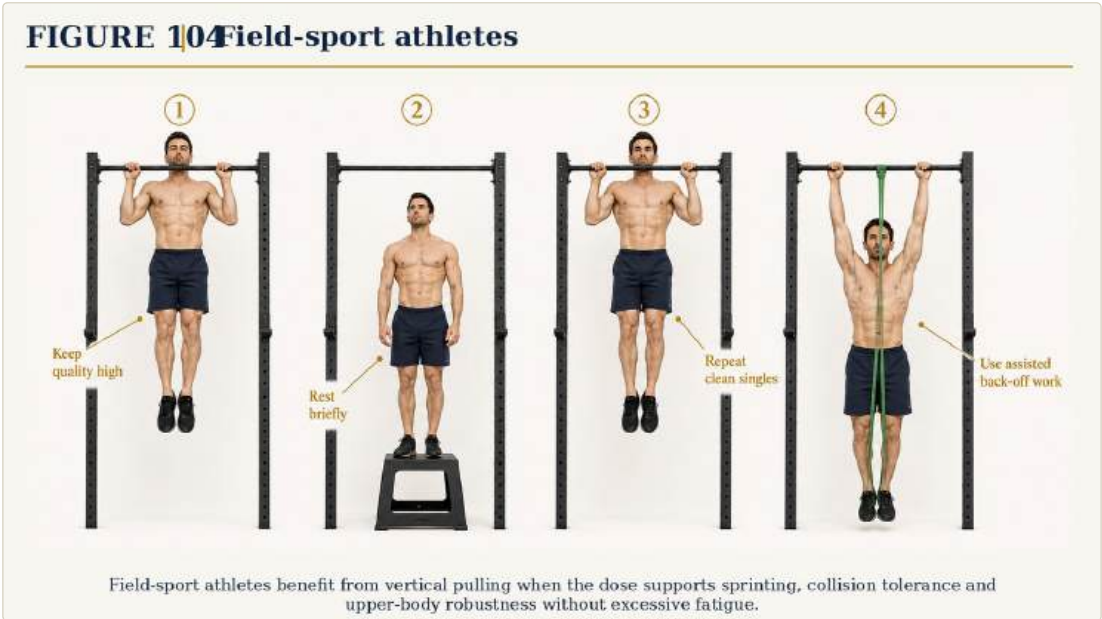
KEY IDEA

For field athletes, the pull is a supporting act. Programme it for efficient strength and durability inside the whole load, not as the main event.

Table 104.1. Field-sport integration

Aim	Approach	Constraint
Upper-body strength	Low-volume strict/weighted pulls.	Fit around sprint/contact load.
Robustness	Scapular and grip control work.	Recovery is the currency.
Efficiency	Few high-quality sets.	Minimum effective dose.

FIGURE 104



Show the minimum-effective-dose approach for a loaded athlete.

MMSx coaching translation: for field athletes, do the least pulling that builds a robust upper body — recovery belongs to the sport.

CHAPTER 105 · PART IX — POPULATION

Combat-sport athletes

Combat athletes value grip, pulling strength and repeated-effort capacity — qualities the vertical pull serves well — but they carry heavy sport loads and frequent minor injuries, so programming prioritises grip robustness and manages fatigue tightly (Chapters 41 and 85). Density and grip-varied work often suit this population better than maximal loading every week.

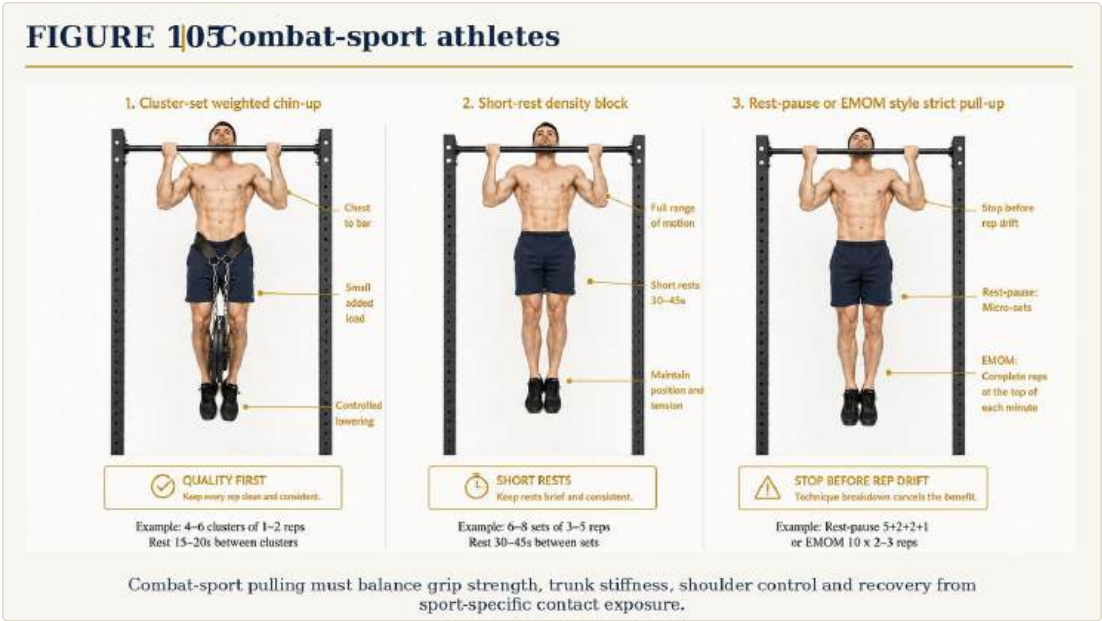
KEY IDEA

Combat athletes want grip and repeatable pulling power, on a busy, knock-prone schedule. Prioritise robustness and manage fatigue over chasing maximal loads.

Table 105.1. Combat-sport priorities

Priority	Method	Watch
Grip & pulling strength	Strict and grip-varied pulls.	Fatigue from sport sparring.
Repeated-effort capacity	Density / cluster methods.	Cumulative load.
Robustness	Scapular and shoulder control.	Minor injuries; adjust weekly.

FIGURE 105



Show the grip-varied, fatigue-managed approach.

MMSx coaching translation: for fighters, build grip and repeatable pull power, but let the week flex around sparring load and knocks.

CHAPTER 106 · PART IX — POPULATION

Masters athletes and adults over 50

Older adults respond well to resistance training, including vertical pulling, and retain a strong capacity to gain strength — but recovery is slower and joint tolerance more variable, so programming favours a thorough warm-up, gradual progression and grip choices that suit the shoulder (Fragala et al., 2019; ACSM, 2009). The pull-up remains an appropriate, adaptable goal well into later life when scaled sensibly.

KEY IDEA

Age is not a contraindication to pulling — it is a reason to progress gradually and choose joint-friendly variants. Strength gains remain very much on the table.

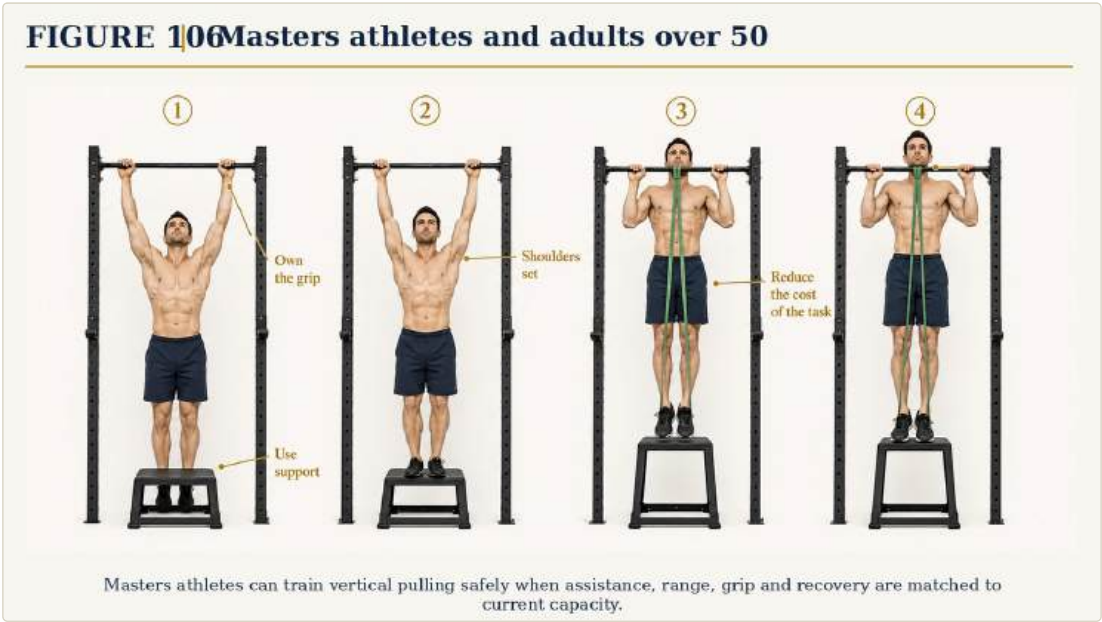
Table 106.1. Masters modifications

Consideration	Adjustment	Rationale
Slower recovery	Lower frequency; longer rests.	Absorb load between sessions.
Joint tolerance	Neutral grip; controlled range.	Shoulder-friendly by default.
Warm-up need	Thorough progressive warm-up.	Prepare tissue for load.

CREDIBILITY & CAUTION

Screen for cardiovascular and other medical considerations common with age, and apply the referral logic of Part VIII. Individual medical clearance takes precedence over any template.

FIGURE 106



Show a joint-friendly scaled pull for the older adult.

MMSx coaching translation: older athletes can absolutely build pulling strength — go neutral, warm up well, progress gently, and clear the medical basics first.

CHAPTER 107 · PART IX — POPULATION

Desk-bound clients and general population

For desk-bound clients, the vertical pull is as much a postural and confidence tool as a strength one: it builds the back and scapular control that offset prolonged sitting, and achieving a first pull-up is a powerful motivator. Programming starts well below the bar (Chapter 61), emphasises scapular control, and progresses patiently around a busy, low-activity lifestyle.

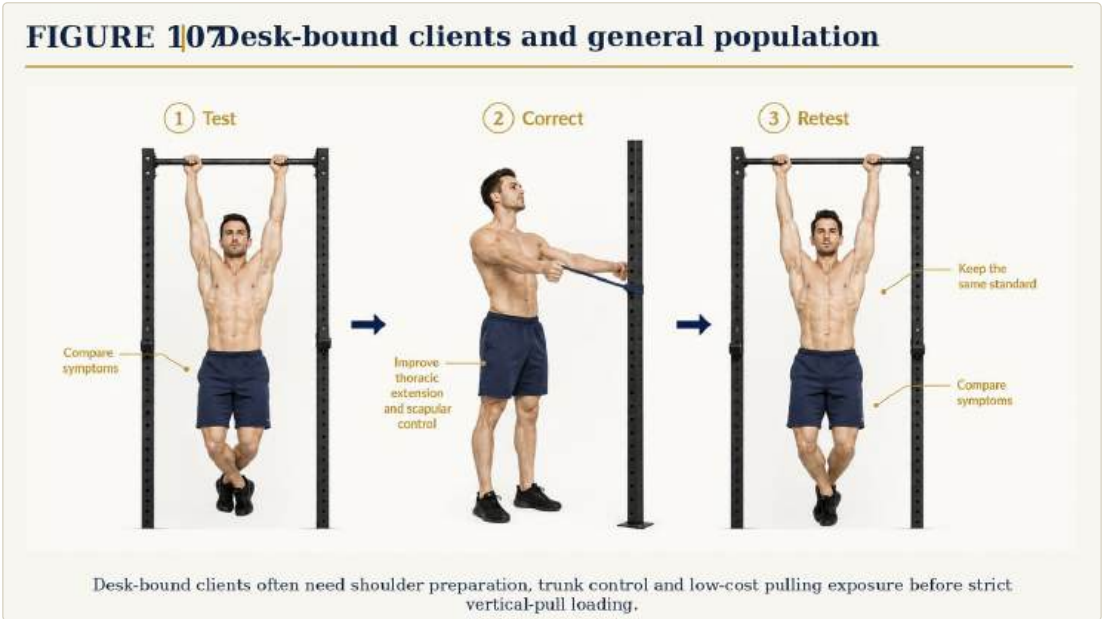
KEY IDEA

For general clients, the pull is posture, strength and motivation in one. Start below the bar, build the platform, and let the first rep be the milestone it deserves to be.

Table 107.1. General-population approach

Aim	Method	Note
Back & scapular health	Rows, scapular pull-ups.	Offsets prolonged sitting.
Access to the bar	On-ramp and assisted work.	Patience; frequent practice.
Motivation	First-rep goal.	Celebrate the milestone.

FIGURE 107



Show the accessible entry path for the general client.

MMSx coaching translation: for desk-bound clients, build the back and scapula, start below the bar, and make the first pull-up a goal worth chasing.

CHAPTER 108 · PART IX — PROGRAMMING

Training vertical pulls with presses, rows, squats and deadlifts

The vertical pull lives inside a whole programme, and it must be balanced against pressing, rowing and lower-body work to build a robust, symmetrical athlete and manage total fatigue (Haff & Triplett, 2016). Balancing vertical and horizontal pulling with pressing supports shoulder health, while sequencing pulls away from competing grip- and back-fatiguing work (heavy deadlifts) preserves quality on both.

KEY IDEA

The pull is one instrument in the orchestra. Balance it with pressing and lower-body work, and sequence it so grip and back fatigue don't rob two lifts at once.

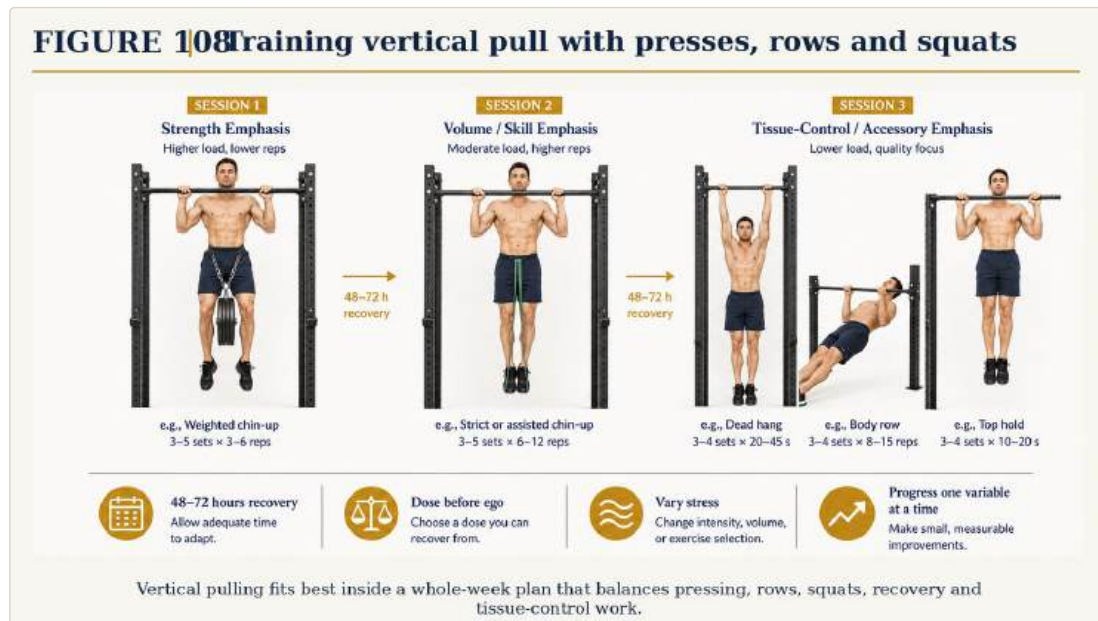
Table 108.1. Weekly integration template (representative)

Day	Primary	Vertical pull role	Balance
Day 1	Upper strength	Weighted/strict pulls (lead)	Press + horizontal row
Day 2	Lower strength	—	Squat pattern
Day 3	Upper volume	Hypertrophy pulls	Press volume + rows
Day 4	Lower / posterior	Light skill pulls (away from deadlift)	Deadlift / hinge

EVIDENCE NOTE

Balancing pulling with pressing volume and controlling total load supports shoulder health and recovery; sequence high grip- and back-demand lifts so they do not degrade each other (Haff & Triplett, 2016; Soligard et al., 2016).

Part X now assembles the reference apparatus — the tools, templates and professional resources that turn this decision science into everyday practice.

FIGURE 108

Design as a printable weekly integration board.

MMSx coaching translation: balance pulls with presses and legs, and keep heavy deadlift and heavy pull days apart so the grip and back aren't taxed twice.

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PART X

Chapters 109 – 120

Reference Apparatus and Professional Tools

A reference is only as useful as the tools it hands the practitioner. This final part turns the decision science into working apparatus — coaching cards, a glossary, a strength-of-evidence grid, templates, assessment sheets, scope-of-practice boundaries and a research agenda — and closes on the single integrated decision model that the whole book has been building toward.

109 • Cards

110 • Glossary

111 • Evidence grid

112 • Asset index

113 • Templates

114 • Assessment

115 • Case metadata

116 • Interpretation

117 • Audit

118 • Ethics/scope

119 • Research

120 • Decision model

CHAPTER 109 · PART X — REFERENCE APPARATUS

Quick-reference coaching cards

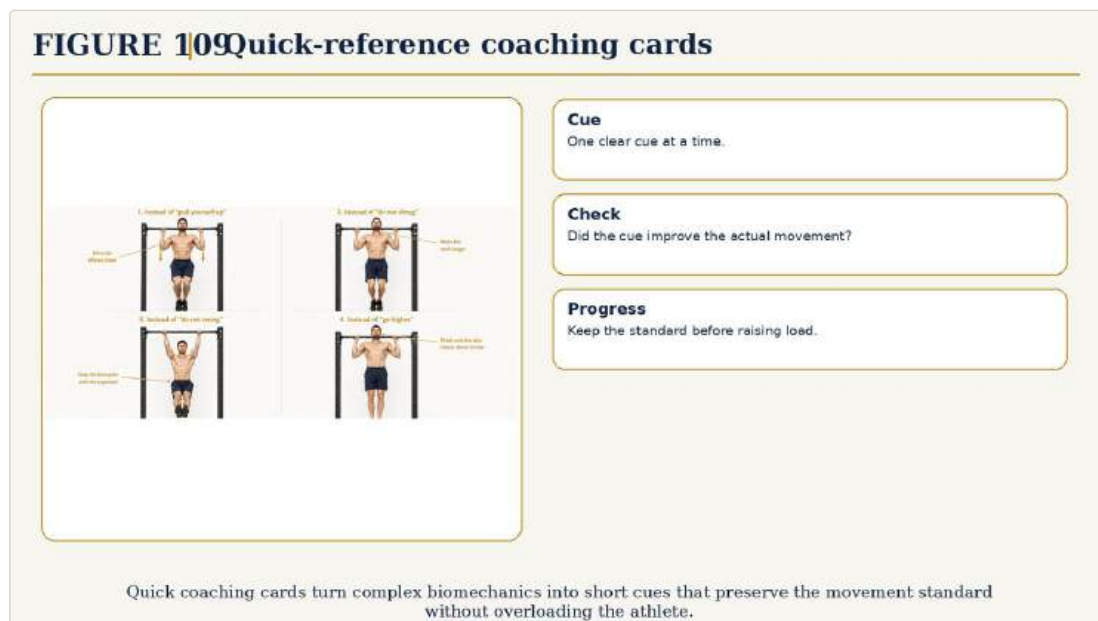
The coaching cards distil the book's decision science into pocket prompts a practitioner can use at the bar. Each card names a decision, the observation that drives it and the first action — no theory, just the operative move. They are designed to be printed and laminated for gym or clinic use.

KEY IDEA

The cards are the book at the point of use. One decision, one observation, one action — theory stripped to what the coach does next.

Grip choice Goal + tolerant joint → supinated (arm), pronated/wide (back), neutral (uncertain).	Set the shoulder Shrug or unset hang → scapular pull-ups; "pull the bar down to you".	Mid-range stall Bar-speed collapse → partial/isometric at that exact angle.
Swing Pendulum at start → brace + "straight-line body"; squeeze legs.	Shoulder niggle Green load · amber dose & watch · red refer. Never argue red into amber.	Progress? Standard held → progress one variable; slipped → regress at failure point.

FIGURE 109



Design as a physical quick-reference deck.

MMSx coaching translation: keep the deck at the bar. When unsure, pull the card, not the theory.

CHAPTER 110 · PART X — REFERENCE APPARATUS

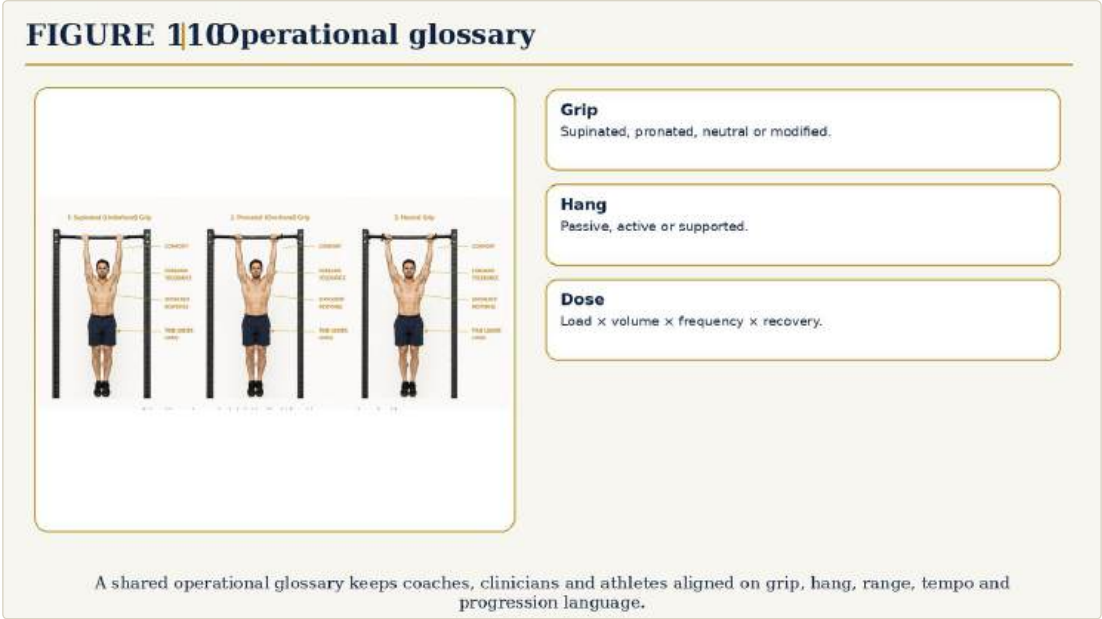
Operational glossary

Precise language is part of a decision science. This glossary fixes the operative terms used throughout the book so that a coach, clinician and researcher can speak to the same definitions rather than approximate synonyms.

Table 110.1. Operational glossary (selected terms)

Term	Operational definition
Moment arm	Perpendicular distance from a joint axis to a force's line of action; sets torque per unit force.
Torque	Rotational effect of a force about a joint (force × moment arm).
Impulse	Force applied over time; changes the body's momentum (launch of the pull).
Centration	Keeping the humeral head seated on the glenoid while the prime movers pull.
Scapulohumeral rhythm	Coordinated humeral and scapular motion (≈2:1 overall) during elevation.
Sticking region	The mid-range where torque demand peaks and most failures occur.
Irritability	How easily symptoms flare and how long they take to settle; governs tolerable load.
Load-capacity	The relationship between applied load and tissue tolerance over time.
External focus	Directing attention to the movement's effect rather than the body part.
RIR / velocity loss	Proximity-to-failure and fatigue markers used to cap a set.

FIGURE 110



Operational glossary.

MMSx coaching translation: agree the words first. A team that defines "centration" or "sticking region" the same way coaches the same thing.

CHAPTER 111 · PART X — REFERENCE APPARATUS

Evidence map and strength-of-evidence grid

Not every claim in a reference of this scope rests on the same strength of evidence, and honesty demands saying so. This grid rates the book's major claim-areas by the maturity of their evidence — from well-established mechanics and loading principles to areas where the direction is reasonable but the specifics remain open. It is a map of confidence, not a scoreboard.

KEY IDEA

State the strength of the evidence, don't imply it. Strong where mechanics and loading are established; more tentative where phase-specific detail is still emerging.

Claim area	Mechanism	Direct evidence	Overall confidence
Joint torque & moment arms	strong	strong	strong
Grip effect on muscle emphasis		moderate	
Load-capacity / injury risk	strong	moderate	strong
Progression & dose-response		moderate	moderate
External-focus cueing	moderate	strong	strong
Phase-specific activation detail	moderate	emerging	moderate
Grip-width fine differences	moderate	emerging	emerging

strong

moderate

emerging

A confidence map across the book's claim-areas, not a quality score of individual studies.

EVIDENCE NOTE

Where the grid reads "emerging", the book states the direction and labels the specifics illustrative rather than asserting precision the literature does not yet support.

FIGURE 111**FIGURE 111 Evidence map and strength-of-evidence grid****Evidence**

EMG, kinematics and training outcomes.

Observation

Video, symmetry and visible compensation.

Response

Symptoms, recovery and adaptation over time.

The evidence map should connect EMG, kinematics, tissue response, training history and coaching observation into one decision model.

Evidence map and strength-of-evidence grid.

MMSx coaching translation: trust the mechanics and the loading principles firmly; hold the fine phase- and width-specifcs lightly.

CHAPTER 112 · PART X — REFERENCE APPARATUS

Visual asset index

The book's real-human figure programme (CU-HUM-001 to CU-HUM-120) is indexed here by part, so the design team can track, brief and place final artwork against the correct serial positions. Each figure placeholder in the text carries its code and a brief describing the required image.

Table 112.1. Real-human figure index by part

Codes	Part	Theme
001-012	I · Foundations	Task, decision framing, four variables.
013-024	II · Physics Engine	Torque, moment arms, impulse, swing.
025-036	III · The Human Machine	Joint-by-joint levers, anthropometry.
037-048	IV · Muscle & Tissue Atlas	Prime movers, controllers, phase matrix.
049-060	V · Phase Atlas / Technique	Six phases; grip & tempo variants.
061-072	VI · Progression	On-ramp to weighted; 24-week plan.
073-084	VII · Assessment & Correction	Screening, error-to-cause, cueing.
085-096	VIII · Pain & Return-to-Load	Load-capacity, referral, return ladder.
097-108	IX · Programming	Goal and population plans; integration.
109-120	X · Reference Apparatus	Cards, grids, templates, decision model.

FIGURE 112



Visual asset index.

MMSx coaching translation: every placeholder is coded and briefed — the design team can drop final figures straight into their serial positions.

CHAPTER 113 · PART X — PROFESSIONAL TOOLS

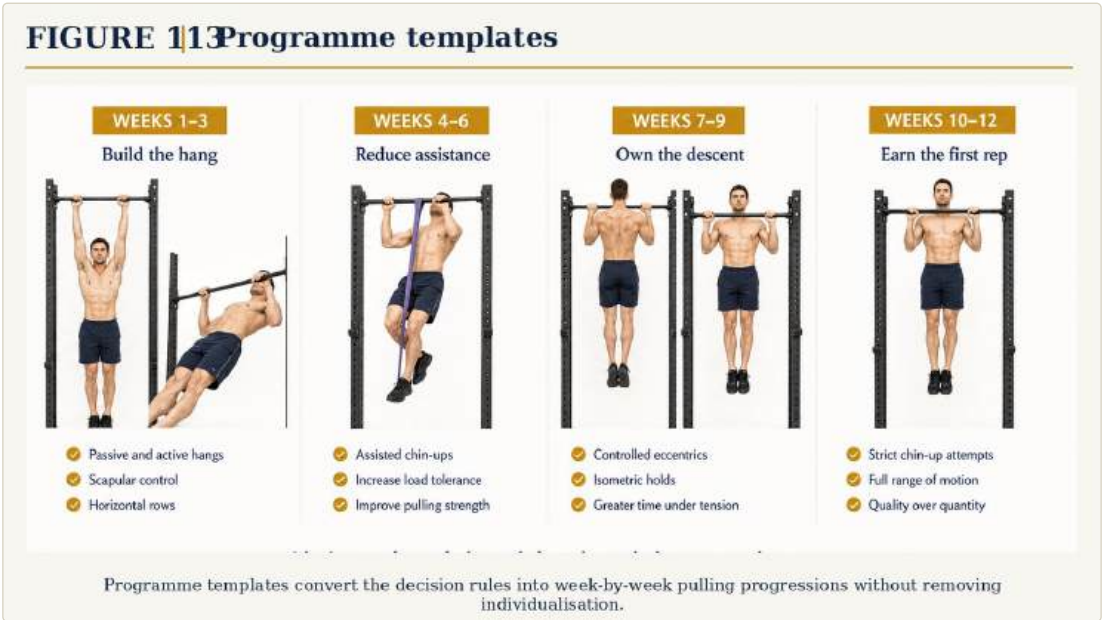
Programme templates

These blank templates turn Part IX into fill-in tools: a weekly skeleton, a block skeleton and a progression log, each carrying the standard-and-retest rule as a built-in prompt so the practitioner records the decision, not just the numbers.

Table 113.1. Weekly template skeleton

Day	Primary	Pull role	Standard / retest
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____

FIGURE 113



Design as fillable professional sheets.

MMSx coaching translation: write the plan on the template and record the standard beside every entry — the log becomes the decision trail.

CHAPTER 114 · PART X — PROFESSIONAL TOOLS

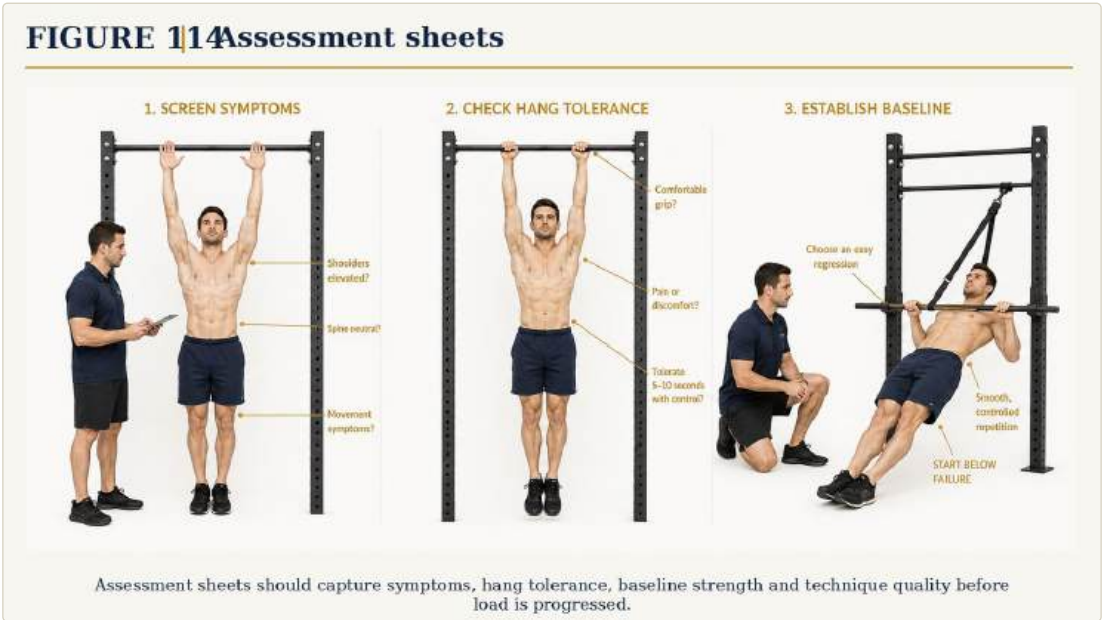
Assessment sheets

The assessment sheet operationalises Part VII: a red-flag screen, the chain checks (grip, shoulder, scapula, trunk), a video-view checklist and a traffic-light outcome, in an order that enforces safety before performance.

Table 114.1. Assessment sheet structure

Section	Records	Output
Red-flag screen	Referral signs present / absent.	Proceed or refer.
Chain checks	Grip, shoulder, scapula, trunk findings.	Entry point / limiter.
Video (S/F/B)	Faults by view and phase.	Diagnosis.
Outcome	Green / amber / red.	Load, dose or refer.

FIGURE 114



Design as a single-page clinical/coaching sheet.

MMSx coaching translation: use the sheet in order — screen, then chain, then video, then decide. The layout keeps safety first.

CHAPTER 115 · PART X — PROFESSIONAL TOOLS

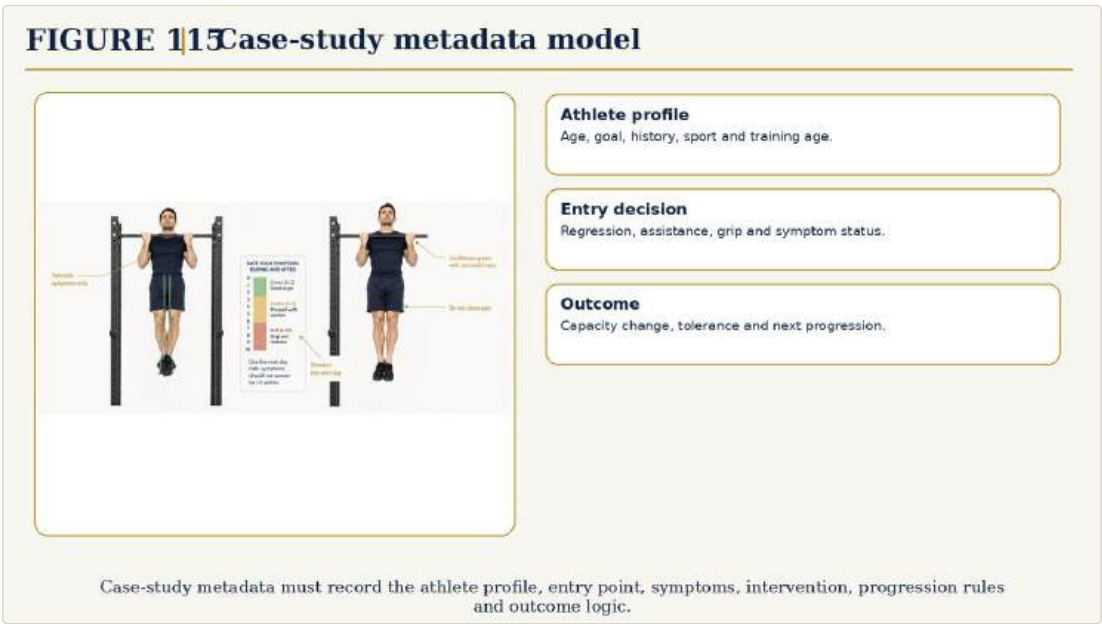
Case-study metadata model

For a case to be comparable and reusable, it must be recorded to a consistent schema. This metadata model captures the athlete context, the decision made, the load applied and the response — the minimum fields that let a case inform future decisions rather than sit as an anecdote.

Table 115.1. Case-study metadata fields

Field	Captures
Context	Population, goal, training age, relevant history.
Anthropometry	Limb-length / mass factors affecting leverage.
Decision	Grip, range, tempo, load selected and why.
Response	Performance, symptoms, 24-hour monitoring outcome.
Revision	What changed at retest and the rationale.

FIGURE 115



Case-study metadata model.

MMSx coaching translation: record context, decision, response and revision. A case logged this way teaches the next decision.

CHAPTER 116 · PART X — PROFESSIONAL TOOLS

Case-study interpretation rules

A case shows what happened for one athlete, not what will happen for all. These interpretation rules guard against over-generalising: read a case as a hypothesis, weight it by how well it was measured, and never let a single vivid result override the load-capacity and evidence logic of the book.

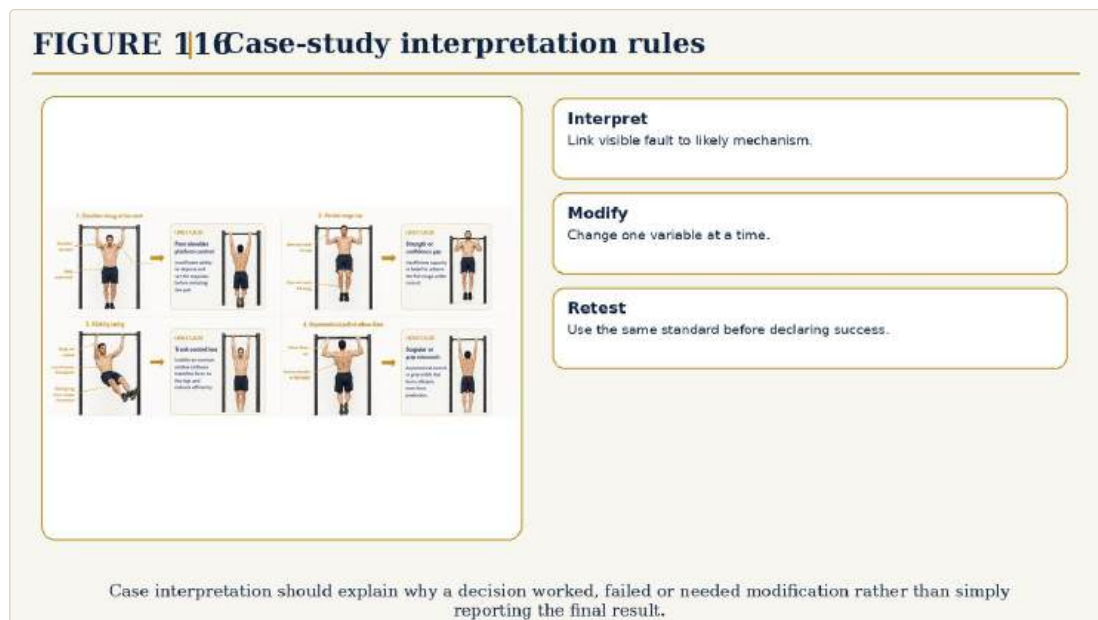
KEY IDEA

A case is a hypothesis, not a law. Weight it by measurement quality and never let one result overturn the principles.



Flowchart 116.1. Interpreting a case without over-generalising.

FIGURE 116



Case-study interpretation rules.

MMSx coaching translation: learn from the case, but don't crown it. One athlete's result is a lead to test, not a rule to impose.

CHAPTER 117 · PART X — PROFESSIONAL TOOLS

Publication audit checklist

A reference earns trust by being verifiable. This checklist is the standard the book itself is held to: real, externally verifiable identifiers only; every claim cited to a genuine source; numbers labelled where illustrative; British English and APA 7th edition throughout; and no fabricated data, effect sizes or credentials (American Psychological Association, 2020).

KEY IDEA

Credibility is a checklist, not a claim. Verifiable identifiers, real citations, honest labelling — the audit is what makes "authoritative" mean something.

Table 117.1. Publication audit checklist

Check	Standard
Identifiers	Externally verifiable only; none fabricated or retired.
Citations	Every claim to a genuine, locatable source; APA 7th.
Numbers	Measured values sourced; illustrative values labelled.
Language	British English throughout; research-institute tone.
Integrity	No fabricated data, effect sizes or credentials.
Identifiers on deposit	DOI shown as assigned on deposit until issued.

FIGURE 117



MMSx coaching translation: run the audit before you publish anything. If a number or identifier can't be verified, label it or remove it.

CHAPTER 118 · PART X — PROFESSIONAL TOOLS

Ethics and scope of practice

Knowing the limits of one's role is an ethical duty, not a disclaimer. A coach optimises movement and load; a clinician diagnoses and treats pathology; the two overlap but are not the same. This book is educational and does not diagnose — and the scope traffic-light keeps each practitioner working within their competence and referring when a situation exceeds it.

KEY IDEA

Scope is an ethical boundary. Coach what you are competent to coach, refer what you are not, and never let a reference substitute for individual clinical assessment.

WITHIN SCOPE

Movement coaching, load management, technique — proceed.

DOSE & MONITOR

Minor, settling symptoms — modify, monitor, document.

REFER OUT

Red flags, diagnosis, persistent/ worsening symptoms — refer.

CREDIBILITY & CAUTION

This reference supports professional decision-making and does not replace individual clinical assessment, diagnosis or treatment by a qualified professional. Movement decisions involve individual risk.

FIGURE 118



Ethics and scope of practice.

MMSx coaching translation: know your lane. Coaching load is yours; diagnosis is not — and the honest referral is the professional move.

CHAPTER 119 · PART X — PROFESSIONAL TOOLS

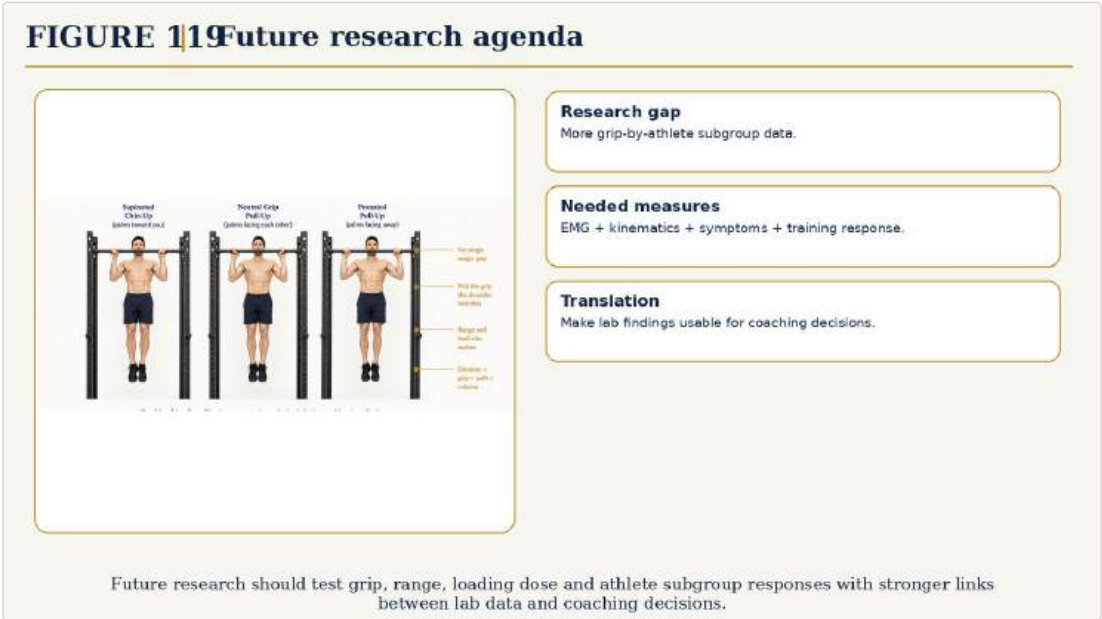
Future research agenda

An honest reference names what it does not yet know. The strength-of-evidence grid (Chapter 111) points directly to the open questions: the phase-specific detail, the fine grip-width effects, and the individualisation of load-capacity that would move claims from "emerging" toward "strong". These are the book's invitations to the field.

Table 119.1. Priority research questions

Open question	Would strengthen
Phase-specific muscle activation in strict pulling	The phase matrix (Ch 48) specifics.
Fine grip-width and orientation effects	Technique-selection precision (Ch 59).
Individualised load-capacity thresholds	Return-to-load dosing (Ch 94-95).
Anthropometric leverage in diverse populations	The leverage-tax model (Ch 33).

FIGURE 119



Future research agenda.

MMSx coaching translation: the honest gaps are the research agenda. Where the grid says "emerging", the field has work to do.

CHAPTER 120 · PART X — THE SYNTHESIS

Final integrated decision model

Everything in this book reduces to one loop. Screen for safety; define the task and its mechanical demand; assess the athlete's capacity and tolerant tissue; select grip, range and tempo to route the demand; programme the load under the capacity line; and monitor the response and retest — then run the loop again as the athlete changes. This is the mechanical decision science of the vertical pull, complete.

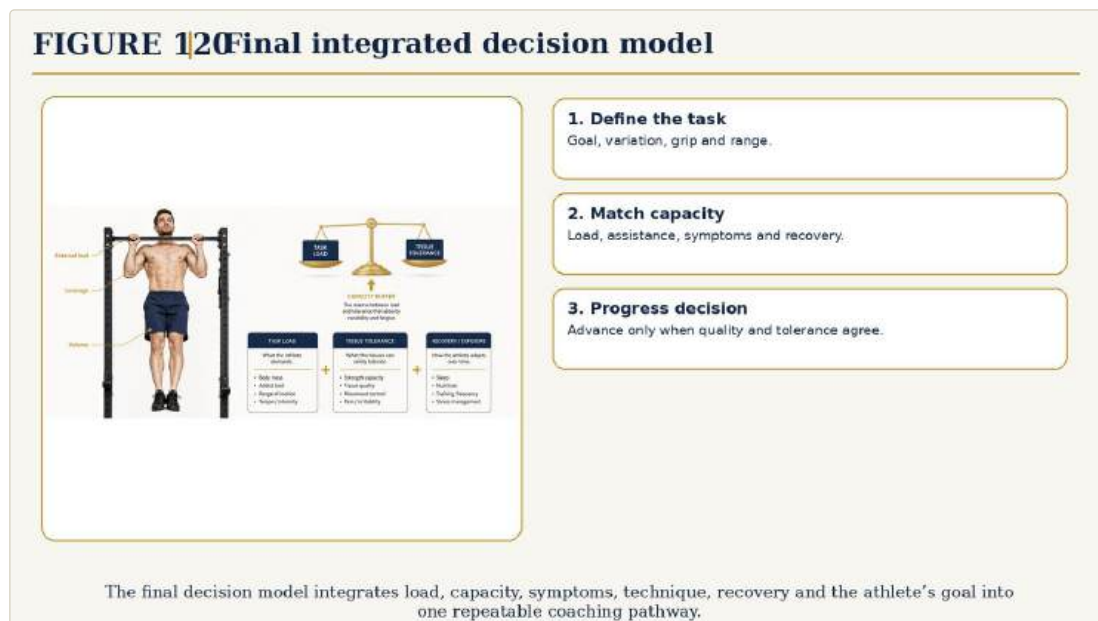
KEY IDEA

The whole book is one repeating decision: screen, demand, capacity, technique, load, monitor — then loop. Every chapter fills in one step; the model is how they work together.



Flowchart 120.1. The MMSx integrated decision model for the vertical pull — the synthesis of Parts I–IX.

FIGURE 120



Design as the book's definitive one-page synthesis.

MMSx coaching translation: when in doubt, run the loop: screen, demand, capacity, technique, load, monitor. The pull-up was a decision science all along.

Sources cited in Part X

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Closing the reference

The chin-up and pull-up look like a single movement, but this reference has treated them as what they are: a mechanical decision science, in which grip, range, tempo and load are chosen deliberately to route demand onto tolerant tissue, build capacity without spikes, and be monitored and revised as the athlete changes.

From the four variables of Part I to the integrated decision model of Part X, the argument has been consistent — read the mechanics, respect the tissue, decide on purpose, and retest. Applied with care and within scope, that discipline turns a hard exercise into a teachable, adaptable and durable skill for almost any body.

MMSx Authority Institute for Movement Mechanics & Biomechanics Research, Inc.
The Chin-Up and Pull-Up: A Complete Mechanical Decision Science — Global
Reference Edition
Educational reference · not a substitute for individual clinical assessment · CC BY
4.0

Consolidated references

A single alphabetised list of every source cited across Parts I–X, in APA 7th edition. Per-part reference lists appear at the end of each part; this master list supports citation checking and further reading.

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Chin-Up & Pull-Up Variation Cards

Complete Biomechanics Reference · 20 variations · two pages each

Twenty of the most common chin-up and pull-up variations, each on a two-page card: the biomechanics lens, a 4 in × 6 in figure slot, the working muscles and what each does, and the core fault → muscular-weakness → correction matrix with a diagnostic flow and dosing logic.

GRIP VARIATIONS

- 01 Pronated (overhand) pull-up
- 02 Supinated (underhand) chin-up
- 03 Neutral-grip pull-up
- 04 Wide-grip pull-up
- 05 Close-grip chin-up
- 06 Mixed-grip pull-up

RANGE & BODY POSITION

- 07 Commando / gate pull-up
- 09 Chest-to-bar pull-up
- 10 Sternum (Gironda) pull-up
- 11 L-sit pull-up
- 17 Typewriter pull-up
- 20 Behind-the-neck **high-risk**

LOADING & TEMPO

- 12 Weighted pull-up
- 15 Negative / eccentric-only
- 16 Towel / thick-grip pull-up

DYNAMIC / SPORT

- 13 Kipping pull-up
- 14 Butterfly pull-up

PROGRESSION & REGRESSION

- 18 Assisted / band pull-up
- 08 Archer pull-up
- 19 One-arm (& assisted one-arm)

How to read a card. Page 1 is the mechanics — spec, lens, figure slot, torque distribution and the working-muscle actions. Page 2 is the clinic — the fault → weak-muscle → correction matrix, a diagnostic loop, and a green/amber/red dosing strip. Muscle attributions are the commonly-associated weaknesses; always confirm against the individual athlete's response. Figure codes CUV-01...20 mark the 4×6 slots for artwork.

Pronated (Overhand) Pull-Up

Grip family: pronated · Vertical pull · Back-dominant variation

GRIP Pronated (overhand)

WIDTH Shoulder-wide

PRIMARY BIAS Latissimus / posterior shoulder

ELBOW DEMAND Moderate

SCAPULAR DEMAND High

RELATIVE DIFFICULTY ●●●●○

Biomechanics lens

The pronated pull-up routes peak demand to the **shoulder**. Pronation removes the biceps' advantage, so the latissimus dorsi and teres major supply most of the humeral extension-adduction torque while the scapular controllers hold the platform. The shoulder's long external moment arm — greatest at wider grips — makes the back demand high, so this variation is harder than the chin-up and more exposing of scapular control.

The rep is decided twice: at **initiation**, where the scapula must set before the elbows bend, and in the **mid-range sticking region** (~90°), where moment arm and torque demand peak together — a back-and-scapula event with the arms as assistants.



Figure 1 · Pronated pull-up with prime-mover lines of pull and the sticking region marked.

Torque distribution — shoulder vs elbow



Pronation shifts the larger torque share to the shoulder/back. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Prime mover — extends and adducts the humerus to raise the body.
Teres major	Synergist — assists the latissimus from the scapula.
Brachialis / brachioradialis	Flex the elbow regardless of grip — the quiet workhorses.
Biceps brachii	Elbow flexion; advantage reduced by the pronated grip.
Lower trapezius	Depresses the scapula; sets the platform before the elbows bend.
Serratus anterior	Holds the scapula flat to the rib cage; drives upward rotation.
Mid-trapezius / rhomboids	Retract and stabilise the scapula through the pull.
Rotator cuff	Centres the humeral head while the big movers pull.
Abdominals / hip flexors	Brace the trunk and hold the hollow line; prevent swing.

KEY MECHANICAL IDEA

A back-and-scapula variation: pronation loads the latissimus, teres major and scapular controllers through a long shoulder moment arm — so most faults trace to those structures, not the arms.

Flaws, muscular weaknesses & corrections

Each common fault in the pronated pull-up maps to a specific under-performing muscle or group. Read the observed error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Shrug / shoulders ride up at start; can't initiate	Lower trapezius, serratus anterior	Scapular depressors fail to set the platform, so the upper trap takes over.	Scapular pull-ups; active-hang depression holds; "shoulders down" cue.
Mid-range stall (~90°)	Latissimus dorsi, teres major	Prime movers under-strong for the peak shoulder moment arm at the sticking angle.	Partial-range reps & isometric holds at that angle; eccentric overload.
Chin fails to clear; elbows flare wide	Mid-trapezius, rhomboids (+ lats)	Insufficient scapular retraction and top-range back strength; arms substitute.	Chest-to-bar drills; paused-top holds; strict full range.
Scapular winging during pull	Serratus anterior	Scapula lifts off the rib cage; force leaks off the platform.	Serratus protraction drills; scapular ladder; controlled tempo.
Body swings / involuntary kip	Rectus abdominis, obliques, hip flexors	Trunk cannot resist extension; a pendulum forms and steals vertical force.	Hollow-body holds; hanging leg raises; "straight-line body" cue.
Neck tightness / upper-trap dominance	Lower trapezius (under-active)	Upper trap compensates for a silent lower trap, compressing the neck.	Lower-trap activation; scapular pull-ups; avoid over-cueing the arms.
Grip fails before the back	Forearm flexors, brachioradialis	Grip endurance caps the set before the prime movers fatigue.	Dead/active hangs; thick-bar work; straps when the back is the target.
Anterior shoulder pinch at top	Rotator cuff (centration)	Loss of humeral-head centration under load/fatigue.	Regress range/volume; centration work; refer if persistent (see caution).

Observe the fault



Locate the weak link in the chain



Load that structure directly



Retest the same standard

Diagnostic loop: correct the muscle behind the fault, not the fault itself, then retest.

GREEN

Pain-free, controlled range → load and progress.

AMBER

Minor, settling symptoms → reduce range/volume; monitor 24 h.

RED

Night/constant pain, weakness, worsening → refer.

CREDIBILITY & CAUTION

This card is educational and does not diagnose. Anterior shoulder pinch, painful arc, night pain, weakness or a sense of instability move the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

MMSx Authority Institute for Movement Mechanics & Biomechanics Research, Inc. · Chin-Up & Pull-Up Variation Cards · Card 01 · Pronated Pull-Up. Educational reference; not a substitute for individual clinical assessment. Muscle attributions reflect commonly-associated weaknesses, corroborated by the athlete's response. Selected sources: Youdas et al. (2010); Signorile et al. (2002); Ludewig & Reynolds (2009); Kibler & Sciascia (2010); Ekstrom et al. (2003); McGill (2007). British English · APA 7th · CC BY 4.0.



Supinated (Underhand) Chin-Up

Grip family: supinated · Vertical pull · Elbow-flexor-biased variation

GRIP Supinated (underhand)

WIDTH Shoulder / close

PRIMARY BIAS Elbow flexors + latissimus

ELBOW DEMAND High

SCAPULAR DEMAND Moderate

DIFFICULTY ●●●○○

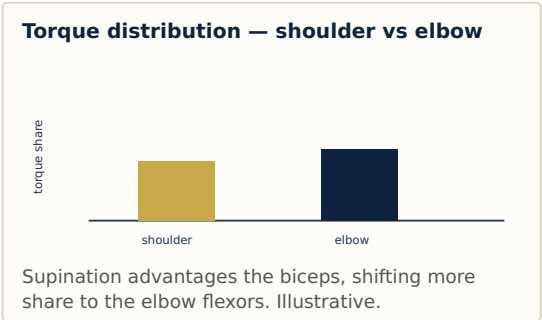
Biomechanics lens

Supination places the biceps brachii at strong mechanical advantage, so the chin-up biases demand toward the elbow flexors while the latissimus still drives the shoulder. It is typically the strongest pull-up variation for a given athlete and a good choice for arm and pulling strength or when the shoulder tolerates supination — but it concentrates load on the elbow, which becomes the likely limiter.

The rep is decided in the mid-range sticking region (~90°), where the elbow-flexor moment arm and external demand are worst together: the biceps and brachialis must generate forces several times the external load through a short internal moment arm.



Figure 2 · Supinated chin-up with the biceps advantage and sticking region marked.



Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Drives humeral extension/ adduction to raise the body.
Biceps brachii	Prime elbow flexor; advantaged by supination, and supinates.
Brachialis	Flexes the elbow regardless of grip — the workhorse underneath.
Teres major	Assists the latissimus from the scapula.
Lower trapezius	Depresses the scapula; sets the platform.
Serratus anterior	Holds the scapula to the rib cage.
Mid-trap / rhomboids	Retract and stabilise the scapula.
Rotator cuff	Centres the humeral head under load.
Abdominals / hip flexors	Brace the trunk; prevent swing.

KEY MECHANICAL IDEA

An elbow-flexor variation: supination advantages the biceps and concentrates demand on the elbow — so the elbow is the usual limiter. Plan for it.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Mid-range stall (~90°)	Biceps brachii, brachialis	Elbow-flexor leverage and demand are worst together at the sticking angle.	Partials & isometrics at that angle; eccentric overload.
Medial (inner) elbow pain	Flexor-pronator group	High supinated volume overloads the flexor-pronator origin.	Reduce supinated volume; rotate to neutral; graded loading.
Shrug / can't initiate	Lower trapezius, serratus anterior	Scapular depressors fail to set the platform.	Scapular pull-ups; “shoulders down”.
Incomplete top range	Mid-trapezius, rhomboids	Weak retraction; arms substitute for the back.	Paused-top holds; strict full range.
Body swing / kip	Abdominals, hip flexors	Trunk cannot resist extension; a pendulum forms.	Hollow holds; hanging leg raises.
Forearm cramp / grip fatigue	Forearm flexors	Sustained supinated grip fatigues the flexors.	Grip work; manage volume; straps when back is target.
Anterior shoulder pinch	Rotator cuff	Loss of humeral-head centration under load.	Regress range/volume; centration work; refer if persistent.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Neutral-Grip Pull-Up

Grip family: neutral (palms facing) · Vertical pull · Balanced, shoulder-friendly variation

GRIP Neutral

WIDTH Shoulder

PRIMARY BIAS Balanced (lat + brachialis)

ELBOW DEMAND Moderate

SCAPULAR DEMAND Moderate

DIFFICULTY ●●●○○

Biomechanics lens

The neutral grip sits between the chin-up and pull-up in muscular bias and is often the most shoulder-friendly option, placing the glenohumeral joint in a comparatively comfortable position and giving the brachioradialis a strong line of pull. It is the low-risk default when a shoulder or elbow is uncertain.

Demand is shared: the latissimus drives the shoulder while the brachioradialis and brachialis handle the elbow without the biceps' full supinated advantage. Faults are generally the mildest of the grip family, which is why this is the first grip to trial when tolerance is unknown.



Figure 3 · Neutral-grip pull-up with the balanced line of pull.

Torque distribution — shoulder vs elbow



Balanced share; the brachioradialis contributes strongly at the elbow. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Extends/adducts the humerus to raise the body.
Brachioradialis	Flexes the elbow with strong advantage in neutral.
Brachialis	Flexes the elbow regardless of grip.
Teres major	Assists the latissimus from the scapula.
Lower trapezius	Depresses the scapula; sets the platform.
Serratus anterior	Holds the scapula to the rib cage.
Mid-trap / rhomboids	Retract and stabilise the scapula.
Rotator cuff	Centres the humeral head.
Abdominals / hip flexors	Brace against swing.

KEY MECHANICAL IDEA

The diplomat grip: balanced demand and a friendly shoulder position make it the safe default when a joint is uncertain.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Shrug / can't initiate	Lower trapezius, serratus anterior	Platform not set before the elbows bend.	Scapular pull-ups; "shoulders down".
Mid-range stall	Latissimus dorsi, brachioradialis	Shared demand under-strong at the sticking angle.	Partials/isometrics at that angle; eccentric overload.
Incomplete top range	Mid-trapezius, rhomboids	Weak scapular retraction.	Paused-top holds; strict full range.
Scapular winging	Serratus anterior	Scapula lifts off the rib cage.	Serratus drills; scapular ladder.
Body swing	Abdominals, hip flexors	Trunk cannot resist extension.	Hollow holds; hanging leg raises.
Grip fatigue	Forearm flexors, brachioradialis	Grip endurance caps the set.	Dead/active hangs; thick-bar work.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

"Shoulder-friendly" is a starting assumption, not a guarantee: confirm tolerance in the individual and progress on symptom response. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Wide-Grip Pull-Up

Grip family: pronated, wide · Vertical pull · Latissimus/scapula-dominant variation

GRIP Pronated

WIDTH Wide

PRIMARY BIAS Latissimus + scapula

ELBOW DEMAND Low-moderate

SCAPULAR DEMAND Very high

DIFFICULTY ●●●●○

Biomechanics lens

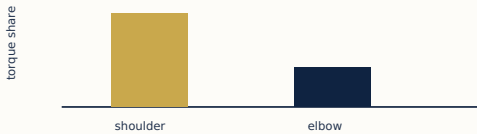
Widening a pronated grip raises latissimus and scapular emphasis, shortens the range, and increases the shoulder's abduction and external demand. It is a back-dominant choice, but the longer external moment arm and greater abduction expose the shoulder more than any other common grip.

Because range is short, top-range and retraction demands are high; and because the biceps advantage is minimal, the back must do proportionally more. Scapular control is the decisive quality here.



Figure 4 · Wide-grip pull-up with the abducted shoulder load and short range.

Torque distribution — shoulder vs elbow



Wide pronation maximises the shoulder/back share and minimises the elbow's. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Prime mover; heavily emphasised at width.
Teres major	Assists the latissimus.
Lower trapezius	Depresses and upwardly rotates the scapula.
Serratus anterior	Holds the scapula to the rib cage; upward rotation.
Mid-trap / rhomboids	Retract and stabilise the scapula.
Brachialis / brachioradialis	Flex the elbow (reduced role).
Rotator cuff	Centres the head against high abduction load.
Infraspinatus / teres minor	External-rotation control at abduction.
Abdominals / hip flexors	Brace against swing.

KEY MECHANICAL IDEA

The most back-and-scapula-dominant common grip — and the most shoulder-exposing. Scapular control and centration are non-negotiable.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Reduced ROM / half-reps	Latissimus, mid-trapezius	Short range plus weak retraction; the chin doesn't clear.	Chest-to-bar & paused-top holds; strict range.
Anterior shoulder pinch	Rotator cuff	High abduction with lost centration.	Narrow slightly; regress; centration work; refer if persistent.
Scapular winging	Serratus anterior	Scapula lifts under the wide load.	Serratus drills; scapular ladder.
Shrug / can't initiate	Lower trapezius	Platform not set.	Scapular pull-ups.
Mid-range stall	Latissimus dorsi, teres major	Long moment arm; prime movers under-strong.	Partials/isometrics; eccentric overload.
Body swing	Abdominals	Trunk cannot resist extension.	Hollow holds.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

Very wide grips raise shoulder abduction and anterior stress; if the shoulder is irritable, narrow the grip and confirm tolerance before loading. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Close-Grip Chin-Up

Grip family: supinated, close · Vertical pull · Elbow-flexor-dominant, long-range variation

GRIP Supinated

WIDTH Close

PRIMARY BIAS Elbow flexors + latissimus

ELBOW DEMAND Very high

SCAPULAR DEMAND Moderate

DIFFICULTY ●●●○○

Biomechanics lens

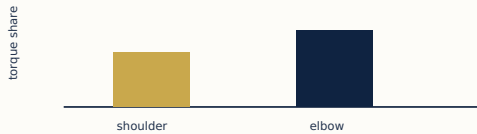
A close supinated grip lengthens the range and maximises elbow-flexor involvement, loading the biceps and brachialis heavily while the latissimus works through a longer pull. It builds arm and pulling strength strongly but concentrates demand — and risk — at the elbow and forearm.

The long range means more work per rep and a prolonged time at the elbow's weakest leverage; grip and forearm can also become the limiter before the back.



Figure 5 · Close-grip chin-up with the long range and heavy elbow-flexor load.

Torque distribution — shoulder vs elbow



Close supination shifts the largest share to the elbow flexors. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Biceps brachii	Prime elbow flexor; strongly advantaged.
Brachialis	Flexes the elbow throughout the long range.
Latissimus dorsi	Drives the shoulder through a longer pull.
Brachioradialis / forearm flexors	Grip and elbow flexion.
Teres major	Assists the latissimus.
Lower trapezius / serratus	Set and hold the platform.
Mid-trap / rhomboids	Retract the scapula.
Rotator cuff	Centres the humeral head.
Abdominals / hip flexors	Brace against swing.

KEY MECHANICAL IDEA

The most elbow-flexor-dominant common grip: long range and heavy biceps load make the elbow and forearm the usual limiters.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Lower/mid-range stall	Biceps brachii, brachialis	Long range at poor elbow leverage.	Partials/isometrics at the sticking angle; eccentric overload.
Medial (inner) elbow pain	Flexor-pronator group	High close-supinated volume.	Reduce volume; rotate to neutral/pronated; graded loading.
Forearm cramp / grip failure	Forearm flexors	Long time under grip tension.	Grip work; hangs; manage volume.
Wrist discomfort	Forearm (set-up)	Close supinated wrist stress.	Check wrist stacking; find a comfortable width.
Incomplete top range	Mid-trapezius, rhomboids	Weak retraction.	Paused-top holds; strict range.
Body swing	Abdominals	Trunk cannot resist extension.	Hollow holds.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

Monitor the medial (inner) elbow closely with high close-supinated volume. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Mixed-Grip Pull-Up

Grip family: mixed (one supinated, one pronated) · Vertical pull · Asymmetric-load variation

GRIP Mixed

WIDTH Shoulder

PRIMARY BIAS Asymmetric (arm-dependent)

ELBOW DEMAND Moderate-high

SCAPULAR DEMAND Moderate

DIFFICULTY ●●●○○

Biomechanics lens

A mixed grip places one forearm supinated and one pronated, producing asymmetric loading: the supinated arm gains biceps advantage while the pronated arm behaves like a pull-up. It is used to shift grip demand and for heavy holds, but it introduces a rotational torque on the trunk and side-to-side asymmetry that must be managed by alternating grips.

The supinated arm's biceps is placed under high load with a long lever — the classic distal-biceps risk position at heavy loads — while the trunk must resist the rotation the asymmetric grip creates.



Torque distribution — shoulder vs elbow



Asymmetric — the supinated arm loads the elbow more, the pronated arm the shoulder. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi (both)	Drive the shoulders to raise the body.
Biceps (supinated arm)	Advantaged elbow flexor under high load.
Brachialis / brachioradialis	Flex the elbows.
Obliques / trunk	Resist the rotation the mixed grip creates.
Teres major	Assists the latissimus.
Lower trapezius / serratus	Set and hold the platform.
Mid-trap / rhomboids	Retract the scapulae.
Rotator cuff	Centres both heads.
Abdominals / hip flexors	Brace and resist rotation.

Figure 6 · Mixed-grip pull-up with the asymmetric load and trunk rotation.

KEY MECHANICAL IDEA

An asymmetric variation: manage side-to-side load by alternating grips and bracing the trunk against rotation — and respect the supinated arm's biceps load.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Trunk rotation / uneven pull	Obliques, trunk wall	The asymmetric grip creates a rotational torque.	Anti-rotation brace cue; alternate grips set to set.
Distal biceps strain (supinated arm)	Biceps brachii	High load on a long, supinated lever.	Avoid maximal grinding; alternate; build tolerance; refer sharp pain.
Side-to-side asymmetry	Latissimus (weaker side)	One side under-contributes.	Address the weaker side; unilateral accessory work.
Shrug / can't initiate	Lower trapezius	Platform not set.	Scapular pull-ups.
Mid-range stall	Latissimus dorsi	Prime movers under-strong.	Partials/isometrics; eccentric overload.
Grip fatigue	Forearm flexors	Grip caps the set.	Hangs; straps when appropriate.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

Alternate grips between sets to balance loading; the supinated arm's biceps is in a vulnerable position under heavy load — avoid maximal grinding and refer any sharp anterior-elbow pain. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Commando / Gate Pull-Up

Grip family: sagittal bar, split grip · Vertical pull · Trunk anti-rotation variation

GRIP Split (over/under, together)

BAR Sagittal (in-line)

PRIMARY BIAS Latissimus + trunk/obliques

ELBOW DEMAND Moderate

SCAPULAR DEMAND Moderate-high

DIFFICULTY ●●●●○

Biomechanics lens

In the commando pull-up the body is under a bar oriented in line with the torso, hands together with one over and one under, and the head passes alternately to each side. This adds a strong anti-rotation and lateral-flexion demand on the trunk on top of the vertical pull, with an asymmetric arm load that alternates side to side.

The pull is as much a trunk event as a back one: the obliques and abdominal wall must resist the rotation and side-bend the offset creates, while the latissimus and elbow flexors raise the body to alternating sides.



Torque distribution — shoulder vs elbow



Vertical demand plus a large anti-rotation trunk component. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Drives the shoulders to raise the body.
Obliques (int./ ext.)	Resist rotation and side-bend to each side.
Rectus abdominis	Braces the trunk against extension.
Biceps (under hand) / brachialis	Flex the elbows; asymmetric per side.
Teres major	Assists the latissimus.
Lower trapezius / serratus	Set and hold the platform.
Quadratus lumborum	Controls lateral flexion to each side.
Rotator cuff	Centres the heads.
Hip flexors	Hold the body line.

Figure 7 · Commando pull-up with the offset grip and anti-rotation demand.

KEY MECHANICAL IDEA

A back-and-trunk variation: the offset bar turns the pull into an anti-rotation and lateral-flexion task — the trunk is the decisive system.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Trunk rotation / lateral sway	Obliques, quadratus lumborum	The trunk cannot resist the offset load.	Anti-rotation trunk work; controlled tempo; hollow line.
Neck strain from head turn	Cervical (set-up)	Forcing the head around the bar.	Lead with a small turn; don't crane; alternate evenly.
Uneven side dominance	Latissimus (weaker side)	One side over-works.	Balance reps to each side; unilateral accessory work.
Shrug / can't initiate	Lower trapezius	Platform not set.	Scapular pull-ups.
Body swing	Abdominals, hip flexors	Trunk cannot hold the line.	Hollow holds.
Grip fatigue	Forearm flexors	The together-grip taxes the forearm.	Grip work; manage volume.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

Alternate sides evenly and avoid forcing the neck around the bar. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Archer Pull-Up

Grip family: wide, unilateral bias · Vertical pull · One-arm progression variation

GRIP Wide (one bent, one straight)

LOAD Unilateral bias

PRIMARY BIAS Single-side lat + elbow

ELBOW DEMAND High (working side)

SCAPULAR DEMAND High

DIFFICULTY ●●●●●

Biomechanics lens

The archer pull-up pulls the body toward one hand while the other arm stays nearly straight and abducted, acting as an assist. This shifts most of the load onto the working side's latissimus and elbow flexors and is a key progression toward the one-arm pull-up. The straight assisting arm reduces but does not remove the load, letting the athlete build unilateral capacity gradually.

The working side faces near-single-arm shoulder and elbow torque with high scapular-control demand, while the assisting arm's shoulder is loaded in abduction. Tolerance must be built before the assist is reduced.



Figure 8 · Archer pull-up with the working-side load and abducted assist arm.

Torque distribution — shoulder vs elbow



Concentrated on the working side; near-single-arm shoulder demand. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi (working side)	Bears most of the pulling torque.
Biceps / brachialis (working side)	High elbow-flexor load.
Lower trapezius / serratus (working side)	Hold a heavily loaded platform.
Teres major	Assists the working latissimus.
Assisting-arm deltoid / cuff	Stabilise the abducted straight arm.
Obliques / trunk	Resist rotation toward the working side.
Mid-trap / rhomboids	Retract and stabilise.
Rotator cuff	Centres the working head under high load.
Hip flexors / abdominals	Hold the body line.

KEY MECHANICAL IDEA

A unilateral-progression variation: near-single-arm load on the working side means scapular control and tissue tolerance must be built before the assist is reduced.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Collapse toward the working side	Working-side lat / scapular controllers	Unilateral load exceeds current capacity.	Increase the assist / reduce range; build unilateral strength.
Working-side elbow overload	Biceps, brachialis	Near-single-arm flexor demand.	Regress the assist; graded loading; monitor the elbow.
Scapular winging (working side)	Serratus anterior	The platform fails under high load.	Serratus/scapular work; regress.
Trunk rotation	Obliques	Trunk cannot resist the unilateral pull.	Anti-rotation trunk work; controlled tempo.
Assisting-shoulder discomfort	Assisting cuff / deltoid	Loaded abduction on the straight arm.	Reduce width; confirm tolerance; refer if persistent.
Body swing	Abdominals, hip flexors	Trunk cannot hold the line.	Hollow holds.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

High unilateral load — build capacity gradually and reduce the assist only when the working side is pain-free and controlled. Refer persistent shoulder or elbow symptoms. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Chest-to-Bar Pull-Up

Grip family: pronated/neutral, full ROM · Vertical pull · Top-range & retraction variation

GRIP Pronated/neutral

RANGE Extended (chest to bar)

PRIMARY BIAS Latissimus + lower trap

ELBOW DEMAND Moderate

SCAPULAR DEMAND Very high

DIFFICULTY ●●●●○

Biomechanics lens

Chest-to-bar raises the finish standard from chin-over to sternum-to-bar, demanding greater range, more scapular retraction and stronger top-range strength than a standard pull-up. The extra range is produced largely by the lower trapezius, rhomboids and latissimus completing the pull past where most reps stop.

Because the hardest part is the top, the retraction and posterior-shoulder demand peaks late; athletes who clear the chin often stall bringing the chest, exposing weak top-range strength.



Figure 9 · Chest-to-bar finish with the top-range retraction demand.

Torque distribution — shoulder vs elbow



Extended range concentrates demand on the back and scapular retractors, especially at the top. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Drives the shoulder through the extended range.
Lower trapezius	Depresses and controls the scapula into the finish.
Mid-trap / rhomboids	Produce the strong top-range retraction.
Teres major	Assists the latissimus.
Posterior deltoid	Assists shoulder extension into the finish.
Serratus anterior	Holds the platform through range.
Brachialis / biceps	Flex the elbow through a longer pull.
Rotator cuff	Centres the head into end-range.
Abdominals / hip flexors	Brace; resist the tendency to lean back.

KEY MECHANICAL IDEA

A top-range variation: the extra distance is retraction work — weak lower trap and rhomboids, not the arms, cause the chest to fall short.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Chin clears but chest won't reach	Mid-trap, rhomboids, lower trapezius	Weak top-range retraction.	Paused-top holds; band-assisted chest-to-bar; retraction drills.
Excessive lean-back to reach	Abdominals (under-brace)	Trunk substitutes lean for retraction.	Brace; controlled body line; reduce range then rebuild.
Mid-range stall	Latissimus dorsi	Prime mover under-strong for the extended range.	Partials/isometrics; eccentric overload.
Shrug / can't initiate	Lower trapezius	Platform not set.	Scapular pull-ups.
Scapular winging	Serratus anterior	Platform fails at end-range.	Serratus drills; scapular ladder.
Posterior shoulder fatigue	Posterior deltoid, rotator cuff	End-range demand under-trained.	Graded top-range volume; monitor.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Sternum (Gironda) Pull-Up

Grip family: supinated/close, extreme ROM · Vertical pull · Maximal-retraction & lean-back variation

GRIP Supinated/close

RANGE Maximal (lower sternum)

PRIMARY BIAS Lat + retractors + thoracic ext.

ELBOW DEMAND High

SCAPULAR DEMAND Maximal

DIFFICULTY ●●●●●

Biomechanics lens

The sternum (Gironda) pull-up extends the range to the extreme — the lower sternum meets the bar with a strong backward lean and thoracic extension — placing maximal demand on the scapular retractors and latissimus and requiring considerable thoracic mobility. It is an advanced variation for top-range back strength.

The pronounced lean and end-range position load the posterior shoulder and thoracic spine heavily; without the mobility and retraction strength to reach the position safely, athletes compensate with lumbar extension.



Figure 10 · Sternal (Gironda) pull-up with the extreme lean and retraction.

Torque distribution — shoulder vs elbow



Extreme range maximises scapular-retractor and latissimus demand with a large thoracic-extension component. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Drives the extended, leaning pull.
Mid-trap / rhomboids	Produce maximal scapular retraction.
Lower trapezius	Depresses and controls the scapula to end-range.
Thoracic erectors	Produce the thoracic extension of the lean.
Biceps / brachialis	Flex the elbow through the long range.
Posterior deltoid	Assists shoulder extension.
Serratus anterior	Holds the platform.
Rotator cuff	Centres the head at end-range.
Abdominals / hip flexors	Control the lean; prevent lumbar over-extension.

KEY MECHANICAL IDEA

A maximal-retraction variation: it needs thoracic mobility and strong retractors — without them the lower back compensates for the lean.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Can't reach sternum to bar	Mid-trap, rhomboids	Maximal retraction strength lacking.	Paused-top & band-assisted holds; retraction volume.
Lumbar over-extension to reach	Abdominals (under-brace); stiff thorax	Lean produced from the low back, not the thorax.	Thoracic mobility; brace; regress range.
Mid-range stall	Latissimus dorsi	Prime mover under-strong.	Partials/isometrics; eccentric.
Posterior shoulder strain	Posterior deltoid, rotator cuff	End-range demand exceeds tolerance.	Regress range/volume; graded loading; refer if persistent.
Elbow overload	Biceps, brachialis	Long supinated range.	Manage volume; monitor the elbow.
Scapular winging	Serratus anterior	Platform fails at extreme range.	Serratus/scapular work.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

Advanced end-range variation — build thoracic mobility and retraction strength first; regress range if the lower back compensates. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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L-Sit Pull-Up

Grip family: any, legs horizontal · Vertical pull · Maximal anti-extension core variation

GRIP Pronated/neutral

BODY L-sit (legs horizontal)

PRIMARY BIAS Lat + trunk/hip flexors

ELBOW DEMAND Moderate

SCAPULAR DEMAND High

DIFFICULTY ●●●●●

Biomechanics lens

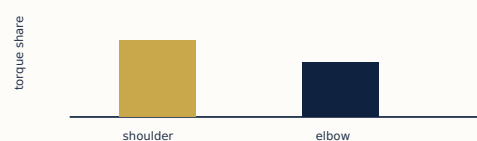
Holding the legs straight out in an L adds a large, sustained anti-extension and hip-flexion demand to the pull. The rectus abdominis, obliques and hip flexors must hold the L against gravity throughout, while the latissimus and scapular controllers perform the pull from a position that resists any swing.

The core, not the back, is usually the limiter: maintaining the L under fatigue is harder than the pull itself, and the fixed body position exposes any tendency to lose the hollow.



Figure 11 · L-sit pull-up with the sustained horizontal-leg core demand.

Torque distribution — shoulder vs elbow



Standard pull demand plus a very high sustained trunk and hip-flexor load. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Rectus abdominis	Holds the trunk flexed against extension.
Hip flexors (iliopsoas, rectus femoris)	Hold the legs horizontal throughout.
Obliques	Stabilise and prevent rotation.
Latissimus dorsi	Drives the pull.
Quadriceps	Keep the knees extended in the L.
Lower trapezius / serratus	Set and hold the platform.
Teres major	Assists the latissimus.
Rotator cuff	Centres the head.
Brachialis / biceps	Flex the elbow.

KEY MECHANICAL IDEA

A core-limited variation: the L is usually harder than the pull — the hip flexors and abdominals decide the set.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Legs drop from horizontal	Hip flexors, rectus abdominis	Anti-extension/hip-flexion endurance insufficient.	L-sit holds; hanging leg raises; tuck progression.
Loss of hollow / swing	Abdominals	Trunk cannot hold position under the pull.	Hollow holds; slow tempo.
Knees bend	Quadriceps	Knee-extension endurance lacking.	Tuck-to-L progression; quad holds.
Mid-range stall	Latissimus dorsi	Prime mover under-strong, compounded by core fatigue.	Partials; regress L to tuck to keep pull quality.
Shrug / can't initiate	Lower trapezius	Platform not set.	Scapular pull-ups.
Grip fatigue	Forearm flexors	Long time under tension.	Hangs; manage volume.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Weighted Pull-Up

Grip family: any + external load · Vertical pull · Maximal-strength variation

GRIP Any (belt / vest load)

LOAD Body weight + added

PRIMARY BIAS Latissimus + elbow flexors

ELBOW DEMAND High

SCAPULAR DEMAND High

DIFFICULTY ●●●●●

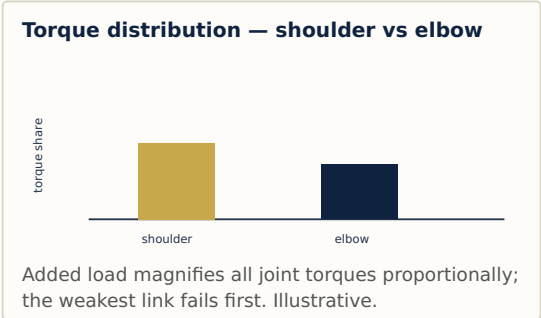
Biomechanics lens

Adding external load raises net demand above body weight and drives maximal strength, magnifying every torque in the chain proportionally. It belongs only on a secure strict base: the added weight amplifies any centration, elbow-tolerance or scapular-control weakness that a body-weight pull would tolerate.

Because demand rises everywhere at once, the weakest link fails first and hardest; small load increments on a clean strict rep are the rule, governed by the load-capacity logic.



Figure 12 · Weighted pull-up with a strict finish under added load.



Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Prime mover; demand amplified by load.
Teres major	Assists the latissimus.
Biceps / brachialis / brachioradialis	Flex the elbow under amplified load.
Lower trapezius / serratus	Hold a heavily loaded platform.
Mid-trap / rhomboids	Retract and stabilise.
Rotator cuff	Centres the head under high, fatigue-sensitive load.
Forearm flexors	Grip the bar under added load.
Abdominals / hip flexors	Brace; the load hangs from the trunk.
Erector spinae	Stabilise the loaded trunk.

KEY MECHANICAL IDEA

A maximal-strength variation: load amplifies every torque, so it belongs only on a pain-free strict base — progress in small increments.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Mid-range stall under load	Latissimus, teres major	Prime movers at their ceiling.	Reduce load; partials/ isometrics; eccentric.
Anterior shoulder pinch	Rotator cuff	Amplified load overwhelms centration.	Reduce load/range; centration; refer if persistent.
Elbow pain under load	Biceps, brachialis	Amplified flexor force.	Reduce load; neutral grip; graded loading.
Grip fails first	Forearm flexors	Added load exceeds grip.	Grip work; straps when back is target.
Scapular drift / winging	Serratus, lower trapezius	Platform fails under load.	Regress load; scapular work.
Half-reps / range loss	Capacity (whole chain)	Load too high for full range.	Cut load until the full-range standard returns.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

Added load magnifies any centration or elbow-tolerance issue. Progress only on a pain-free strict base with small increments, applying load-capacity and 24-hour monitoring. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Kipping Pull-Up

Grip family: pronated, dynamic · Vertical pull · Hip-drive / impulse variation

GRIP Pronated

STYLE Dynamic (kip)

PRIMARY BIAS Hip drive + lat + trunk

ELBOW DEMAND Moderate

SCAPULAR DEMAND High (dynamic)

DIFFICULTY ●●●●○

Biomechanics lens

The kipping pull-up uses a rhythmic hip and trunk swing to generate upward impulse, so the hips — not only the arms — pay for the launch. It permits higher repetition volume and speed, but transfers large, rapid loads to the shoulder at end-range, demanding excellent scapular control and cuff centration under dynamic conditions.

The technique is a legitimate sport-specific skill, not “cheating”, but it is inappropriate before a strict base and controlled scapular rhythm exist; the risk is a fast, repeated end-range shoulder load.

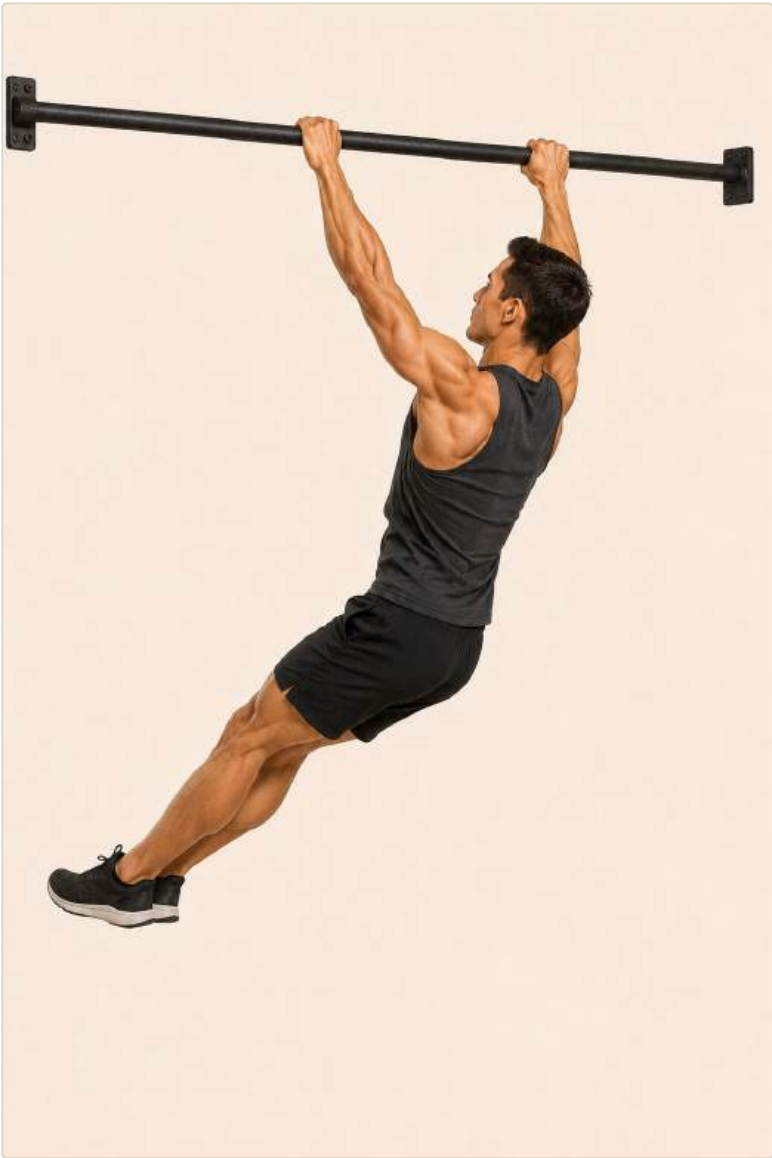


Figure 13 · Kipping pull-up with the hip-driven arch-to-hollow launch.

Torque distribution — shoulder vs elbow



Hip impulse supplies much of the launch; rapid end-range load shifts to the shoulder. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Hip flexors / extensors	Generate the kip's driving swing.
Rectus abdominis / obliques	Transmit the drive; control the arch-to-hollow.
Latissimus dorsi	Converts momentum into the pull.
Lower trapezius / serratus	Control the scapula through a dynamic range.
Posterior deltoid	Absorbs rapid end-range load.
Teres major	Assists the latissimus.
Rotator cuff	Centres the head under dynamic load.
Forearm flexors	Grip through repeated swings.
Erector spinae	Control the arch phase.

KEY MECHANICAL IDEA

A hip-driven variation: the kip buys impulse with the hips but repeatedly loads the shoulder fast at end-range — it needs a strict base and dynamic scapular control first.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Shoulder pain at end-range	Rotator cuff, posterior deltoid	Rapid dynamic load exceeds centration/tolerance.	Regress to strict; build dynamic control; refer if persistent.
Loss of arch-hollow rhythm	Abdominals, hip flexors	Poor kip timing; energy leaks.	Drill the kip swing separately; tempo control.
No strict base	Latissimus (under-strong)	Kipping substitutes for absent strength.	Build strict reps first, then add the kip.
Scapular loss of control	Lower trap, serratus	Platform not controlled dynamically.	Scapular control drills; slow the kip.
Grip failure	Forearm flexors	High-volume swinging taxes grip.	Grip work; manage volume.
Lumbar over-extension	Abdominals (under-brace)	Arch phase uncontrolled.	Brace; control the arch range.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

Kipping loads the shoulder rapidly at end-range and is inappropriate before a strict base and controlled scapular rhythm exist. Build strict strength first; regress and refer any dynamic-load shoulder pain. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Butterfly Pull-Up

Grip family: pronated, continuous cyclical · Vertical pull · High-cycle-rate kip variation

GRIP Pronated

STYLE Continuous cyclical kip

PRIMARY BIAS Hip drive + lat + trunk

ELBOW DEMAND Moderate

SCAPULAR DEMAND Very high (dynamic)

DIFFICULTY ●●●●●

Biomechanics lens

The butterfly pull-up replaces the kip's back-and-forth with a continuous circular path, allowing very high repetition rates in competition. It is the most dynamic common variation, cycling the shoulder rapidly through end-range under load — so it demands the highest level of scapular control, cuff centration and timing of any pull here.

The continuous cycle removes the brief pause of a standard kip, so the shoulder never fully unloads; without excellent control and capacity, the cumulative end-range load becomes a significant risk.



Figure 14 · Butterfly pull-up with the continuous circular cycle.

Torque distribution — shoulder vs elbow



Continuous hip-driven cycling; the shoulder is loaded rapidly and repeatedly at end-range. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Hip flexors / extensors	Drive the continuous circular kip.
Rectus abdominis / obliques	Time and transmit the cycle.
Latissimus dorsi	Converts momentum into the pull each cycle.
Lower trapezius / serratus	Control the scapula through rapid cycling.
Rotator cuff	Centres the head under repeated dynamic load.
Posterior deltoid	Absorbs end-range load each cycle.
Teres major	Assists the latissimus.
Forearm flexors	Grip through high-rate cycling.
Erector spinae	Control the arch phase.

KEY MECHANICAL IDEA

The most dynamic variation: continuous cycling never unloads the shoulder — reserve for advanced athletes with proven strict strength and scapular control.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Cumulative shoulder pain	Rotator cuff, posterior deltoid	Rapid repeated end-range load.	Regress to strict/standard kip; build capacity; refer if persistent.
Timing breakdown	Abdominals, hip flexors	Continuous rhythm lost; jarring loads.	Drill the cycle slowly; rebuild rhythm.
No strict/kip base	Latissimus, scapular controllers	Skipping prerequisites.	Master strict then standard kip first.
Scapular loss of control	Lower trap, serratus	Platform uncontrolled at speed.	Dynamic scapular control; reduce rate.
Grip failure	Forearm flexors	Very high rep rate.	Grip work; cap volume.
Lumbar over-extension	Abdominals	Uncontrolled arch.	Brace; control the arch.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

The most dynamic variation — reserve for advanced athletes with proven strict strength and scapular control. It loads the shoulder rapidly and continuously at end-range; regress and refer any shoulder symptoms. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Negative / Eccentric-Only Pull-Up

Grip family: any, eccentric-only · Vertical pull · Eccentric-overload / bridging variation

GRIP Any

PHASE Eccentric-only (lower slowly)

PRIMARY BIAS Lat + elbow flexors (eccentric)

ELBOW DEMAND High (eccentric)

SCAPULAR DEMAND Moderate

DIFFICULTY ●●○○○ (scalable)

Biomechanics lens

The negative pull-up trains only the lowering phase: the athlete reaches the top by step or jump, then lowers under control. Because eccentric strength exceeds concentric, it lets those who cannot yet pull up build full-range strength — including through the sticking region — and is one of the most effective bridges to a first strict rep.

The controlled lowering loads the latissimus and elbow flexors eccentrically through the whole range; progression lengthens the descent and reduces any assistance to the top.



Torque distribution — shoulder vs elbow



Eccentric loading of the prime movers and elbow flexors through the full range. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Lowered under eccentric control through range.
Biceps / brachialis	Control elbow extension eccentrically.
Teres major	Assists eccentrically.
Lower trapezius / serratus	Control scapular position through the descent.
Mid-trap / rhomboids	Manage retraction into the descent.
Rotator cuff	Centres the head, especially at the bottom.
Forearm flexors	Hold the grip through a long descent.
Abdominals / hip flexors	Hold the body line.
Erector spinae	Stabilise the trunk.

Figure 15 · Negative pull-up with the controlled full-range descent.

KEY MECHANICAL IDEA

An eccentric-bridge variation: controlled lowering builds full-range strength and is the fastest route to a first strict rep — progress by lengthening the descent.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Descent uncontrolled / fast drop	Latissimus, biceps (eccentric)	Eccentric strength insufficient.	Shorten the descent; more assistance to the top; build gradually.
Bottom drop-off	Rotator cuff, lower trapezius	Loss of control/centration at end-range.	Control the last third; active-hang finish.
Shoulder yank at bottom	Rotator cuff	Ballistic bottoming out.	Slow the last third; avoid the dead drop.
Body swing	Abdominals, hip flexors	Trunk not braced.	Hollow line; slow tempo.
Grip fails mid-descent	Forearm flexors	Long time under tension.	Grip work; shorten the descent.
Elbow strain	Biceps, brachialis	High eccentric elbow load.	Manage volume; monitor the elbow.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

A dropped bottom loads the shoulder and elbow abruptly at end-range; control the last third of the descent and avoid ballistic bottoming. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Towel / Thick-Grip Pull-Up

Grip family: thick/irregular · Vertical pull · Maximal grip-demand variation

GRIP Towel / thick bar

WIDTH Shoulder

PRIMARY BIAS Grip + forearm + lat

ELBOW DEMAND Moderate

SCAPULAR DEMAND Moderate

DIFFICULTY ●●●●○

Biomechanics lens

Gripping a towel or thick bar sharply raises the demand on the forearm flexors and grip, because a larger or compressible surface reduces mechanical advantage and forces greater crush force. The pull itself is a standard pull-up, but grip becomes the deliberate limiter — the point of the variation for climbers and grip-sport athletes.

Because grip fails first by design, the back and elbow rarely reach failure; the risk shifts to the forearm, medial elbow and fingers if volume is progressed too fast.



Figure 16 · Towel / thick-grip pull-up with grip as the deliberate limiter.

Torque distribution — shoulder vs elbow



Standard pull demand, but grip and forearm are the deliberate limiter. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Forearm flexors (FDS / FDP)	Crush the towel/thick bar — the deliberate limiter.
Brachioradialis	Flexes the elbow and assists the grip.
Latissimus dorsi	Drives the pull.
Teres major	Assists the latissimus.
Lower trapezius / serratus	Set and hold the platform.
Biceps / brachialis	Flex the elbow.
Rotator cuff	Centres the head.
Mid-trap / rhomboids	Retract the scapula.
Abdominals / hip flexors	Brace against swing.

KEY MECHANICAL IDEA

A grip-limited variation by design: the forearm flexors fail first, so progress grip volume conservatively and watch the elbow and fingers.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Early grip failure (intended)	Forearm flexors	Thick/compressible surface raises crush demand.	Progress grip volume gradually; hangs; chalk.
Medial (inner) elbow pain	Flexor-pronator group	Grip-heavy volume overloads the origin.	Reduce grip volume; graded loading; monitor.
Finger / tissue soreness	Finger flexors	Overreaching grip tissue.	Conservative progression; hand care.
Uneven towel grip	Forearm (weaker side)	Asymmetric towel hold.	Balance load; symmetrical set-up.
Shrug / can't initiate	Lower trapezius	Platform not set.	Scapular pull-ups.
Mid-range stall	Latissimus dorsi	Prime mover under-strong (rare — grip usually fails first).	Partials; or strap to train the back directly.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

Grip- and forearm-heavy loading overreaches easily — progress conservatively and watch the medial elbow and finger tissues. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Typewriter Pull-Up

Grip family: wide, lateral traverse · Vertical pull · Top-range unilateral traverse variation

GRIP Wide

MOVEMENT Top traverse, side to side

PRIMARY BIAS Single-side lat + retractors (end-range)

ELBOW DEMAND High (each side)

SCAPULAR DEMAND Very high

DIFFICULTY ●●●●●

Biomechanics lens

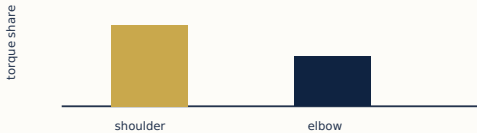
The typewriter pull-up holds the top position and traverses the body laterally from one hand to the other, so each side bears a near-unilateral end-range load while the chin stays over the bar. It marries top-range strength with a moving, single-side demand and is among the most shoulder-intensive common variations.

The sustained top position means the scapular retractors and cuff work at their shortest, most demanding length while the load shifts side to side; end-range control and tolerance are decisive.



Figure 17 · Typewriter pull-up with the top-held lateral traverse.

Torque distribution — shoulder vs elbow



Sustained top-range load traversing side to side; near-unilateral at each end. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi (loaded side)	Holds the top and bears the traverse load.
Mid-trap / rhomboids	Sustain retraction at the top throughout.
Lower trapezius / serratus	Hold the shortened platform.
Biceps / brachialis (each side)	Flex the elbow at end-range.
Obliques / trunk	Resist rotation during the traverse.
Posterior deltoid	Assists the end-range shoulder position.
Rotator cuff	Centres the head at end-range under shifting load.
Teres major	Assists the latissimus.
Hip flexors / abdominals	Hold the body line.

KEY MECHANICAL IDEA

A moving top-range variation: near-unilateral end-range load traverses side to side — end-range scapular and cuff control must be strong before attempting it.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Drops below the bar mid-traverse	Mid-trap, rhomboids, lat (loaded side)	Top-range/unilateral strength insufficient.	Build top-range holds & archer first; reduce traverse width.
Shoulder pinch at end-range	Rotator cuff	Shortened, shifting end-range load exceeds centration.	Regress range; centration; refer if persistent.
Trunk rotation during traverse	Obliques	Trunk cannot resist the shifting load.	Anti-rotation work; controlled tempo.
Scapular winging (loaded side)	Serratus anterior	Platform fails at end-range.	Serratus/scapular work; regress.
Elbow overload	Biceps, brachialis	Near-single-arm end-range flexion.	Reduce width/volume; monitor the elbow.
Body swing	Abdominals, hip flexors	Body line lost.	Hollow holds.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

A shoulder-intensive end-range variation — attempt only with strong top-range and unilateral control (archer and top-holds first). Regress range and refer persistent shoulder or elbow symptoms. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Assisted / Band Pull-Up

Grip family: any, assisted · Vertical pull · Regression / capacity-building variation

GRIP Any

ASSISTANCE Band / machine

PRIMARY BIAS Lat + elbow flexors (reduced load)

ELBOW DEMAND Low-moderate

SCAPULAR DEMAND Moderate

DIFFICULTY ●○○○○ (scalable)

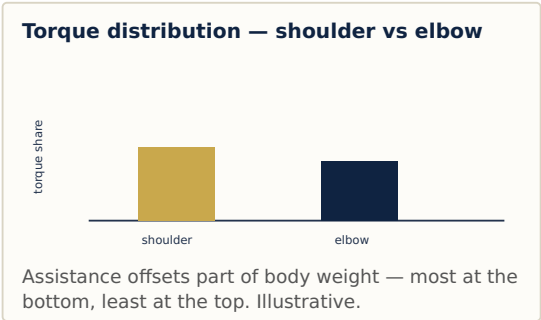
Biomechanics lens

Band or machine assistance lowers the effective load so a full-range pull can be trained before body-weight strength exists, making it the primary entry and regression variation. A band gives most help at the bottom, where it is stretched, and least at the top — conveniently supporting the sticking region while still demanding a real top-range finish.

It builds the exact pattern and range of the target rep at a scalable load; progression reduces assistance (lighter band, less counterweight) toward an unassisted rep. The main pitfall is leaning on assistance rather than systematically removing it.



Figure 18 · Band-assisted pull-up building the full-range pattern.



Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Drives the pull at reduced load.
Biceps / brachialis	Flex the elbow (assisted).
Lower trapezius / serratus	Set and hold the platform.
Teres major	Assists the latissimus.
Mid-trap / rhomboids	Retract the scapula.
Rotator cuff	Centres the head.
Forearm flexors	Grip the bar.
Abdominals / hip flexors	Brace; control any band bounce.
Erector spinae	Stabilise the trunk.

KEY MECHANICAL IDEA

A scalable regression: assistance builds the true full-range pattern before body-weight strength exists — the discipline is to reduce the assistance, not rely on it.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Over-reliance / no progression	Latissimus (under-loaded)	Assistance not reduced over time.	Systematically lighten the band/counterweight.
Band bounce at the bottom	Abdominals (under-control)	Elastic recoil throws the start.	Control the bottom; don't ride the bounce.
Top-range still fails	Mid-trap, rhomboids	The band gives least help where retraction is needed.	Paused-top holds; targeted retraction work.
Shrug / can't initiate	Lower trapezius	Platform not set despite assistance.	Scapular pull-ups.
Range shortcut	Standard (whole pattern)	Assistance masks incomplete range.	Hold the full-range standard even when assisted.
Grip fatigue	Forearm flexors	Grip still caps longer sets.	Dead/active hangs; grip work.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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One-Arm Pull-Up (and Assisted One-Arm)

Grip family: single-arm · Vertical pull · Apex unilateral strength variation

GRIP Single-arm (± assist)

LOAD Full body on one arm

PRIMARY BIAS One-side lat + elbow + scapula

ELBOW DEMAND Maximal

SCAPULAR DEMAND Maximal

DIFFICULTY ●●●●● (elite)

Biomechanics lens

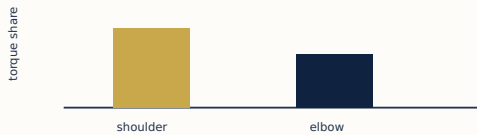
The one-arm pull-up places the entire body weight on a single latissimus, elbow-flexor group and scapular platform, with a very large anti-rotation demand on the trunk to stop the body spinning. It is the apex of the pulling progression and requires years of unilateral capacity built through archer, typewriter and assisted one-arm work.

Every structure in the working chain operates near its ceiling, and the shoulder must stay centred under maximal single-arm load; the assisted one-arm — opposite hand on the wrist, forearm or a band — is the essential bridge that reduces load while preserving the pattern.



Figure 19 · One-arm pull-up with the maximal single-side load and anti-rotation.

Torque distribution — shoulder vs elbow



Full body weight on one side; maximal shoulder and elbow torque plus large anti-rotation. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi (working)	Bears the entire pulling load alone.
Biceps / brachialis (working)	Maximal single-arm elbow flexion.
Lower trapezius / serratus (working)	Hold the platform at maximal load.
Obliques / trunk	Resist strong rotation of the whole body.
Rotator cuff	Centres the head under maximal load — critical.
Mid-trap / rhomboids	Sustain retraction.
Teres major	Assists the working latissimus.
Forearm flexors	Single hand holds all body weight.
Hip flexors / abdominals	Hold the body line; damp swing.

KEY MECHANICAL IDEA

The apex unilateral variation: every working structure runs near its ceiling — earn it through archer, typewriter and assisted one-arm work, never rushed.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Body spins / can't control rotation	Obliques, trunk wall	Anti-rotation capacity insufficient.	Build anti-rotation strength; assisted one-arm first.
Can't pass mid-range	Working latissimus, biceps	Single-arm strength not yet built.	More assist (wrist/band); archer & typewriter progression.
Shoulder strain under load	Rotator cuff	Maximal load exceeds centration/tolerance.	Regress the assist; centration; refer if persistent.
Distal-biceps / tendon pain	Biceps, brachialis	Maximal single-arm flexor load.	Reduce load/volume; graded loading; refer sharp pain.
Scapular winging (working)	Serratus anterior	Platform fails at maximal load.	Regress; serratus/scapular work.
Grip fails	Forearm flexors	One hand holds all body weight.	Dedicated grip strength; chalk.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

An elite variation loading one shoulder, elbow and grip near their ceiling. Progress only through assisted one-arm, archer and typewriter stages over long timeframes; maintain centration and refer any sharp elbow or shoulder pain immediately. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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Behind-the-Neck Pull-Up

Grip family: pronated, wide, posterior · Vertical pull · High-risk end-range position variation

- GRIP Pronated, wide
- PATH Behind the neck
- PRIMARY BIAS Lat + scapula (provocative position)
- ELBOW DEMAND Moderate
- SCAPULAR DEMAND Very high
- RISK PROFILE Elevated

Biomechanics lens

The behind-the-neck pull-up brings the bar behind the head, forcing the shoulders into combined maximal abduction and external rotation — the classic apprehension position — while also demanding a forward-head, flexed-cervical posture. It biases the latissimus and scapular retractors but places the glenohumeral joint in one of its least stable, most provocative positions under load.

The mechanical cost is a markedly higher exposure to anterior instability, impingement and cervical strain than a front pull-up, for no unique strength benefit the front version cannot provide more safely. For most athletes the front-of-neck pull-up is the better choice; where the behind-the-neck is used at all, it demands exceptional mobility, control and conservative loading.



Figure 20 · Behind-the-neck pull-up shown as a provocative end-range position.

Torque distribution — shoulder vs elbow



Back-biased, but produced in a provocative abducted, externally-rotated shoulder position. Illustrative.

Working muscles — what each does in this pull

Muscle	Action in the movement
Latissimus dorsi	Drives the posterior pull.
Mid-trap / rhomboids	Retract strongly into the behind-neck finish.
Lower trapezius / serratus	Attempt to stabilise a provocative platform.
Rotator cuff (subscapularis, infraspinatus)	Fight to centre the head in the apprehension position.
Posterior deltoid	Assists the posterior path.
Biceps / brachialis	Flex the elbow.
Deep neck flexors	Control the forward-head position.
Teres major	Assists the latissimus.
Abdominals / hip flexors	Brace against swing.

KEY MECHANICAL IDEA

A high-risk position with no unique benefit: combined abduction and external rotation put the shoulder in the apprehension position — for most athletes, choose the front pull-up instead.

Flaws, muscular weaknesses & corrections

Each common fault maps to a specific under-performing muscle or group. Read the error, identify the weak structure behind it, and apply the correction that loads exactly that structure.

Fault → muscular weakness → correction

Observed fault	Weak / at-fault muscle	Why it happens	Correction
Anterior shoulder apprehension / pain	Rotator cuff (subscapularis), capsule	The apprehension position under load.	Stop; switch to the front pull-up; refer if symptomatic.
Impingement pinch	Cuff, subacromial structures	Maximal abduction compresses the subacromial space.	Discontinue behind-neck; front variation; refer if persistent.
Neck / cervical strain	Deep neck flexors	Forced forward-head, flexed-neck posture.	Avoid craning; discontinue; front variation.
Can't reach behind cleanly	Shoulder mobility (ER/abduction)	Insufficient mobility for the position.	Do not force; front pull-up; targeted mobility only if indicated.
Scapular winging	Serratus anterior	Platform unstable in the provocative position.	Discontinue; scapular work with the front variation.
Mid-range stall	Latissimus dorsi	Prime mover under-strong.	Train the front pull-up instead.



Diagnostic loop: correct the muscle behind the fault, then retest.

GREEN Pain-free, controlled range → load and progress.	AMBER Minor, settling symptoms → reduce range/volume; monitor 24 h.	RED Night/constant pain, weakness, worsening → refer.
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CREDIBILITY & CAUTION

STRONGER CAUTION — not recommended for most athletes. The behind-the-neck position combines maximal abduction and external rotation (the apprehension position) with forced cervical flexion, carrying elevated anterior-instability, impingement and neck-strain risk for no benefit the front pull-up cannot provide more safely. It is contraindicated with any shoulder instability, impingement history or cervical issue. If any apprehension, pinch or neck symptom occurs, discontinue immediately and refer. This card is educational and does not diagnose. Night or constant pain, weakness, a painful give-way or a sense of instability under load moves the decision toward referral. Regress load and reassess; refer persistent or worsening symptoms to a qualified professional.

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SCIENCE. STRENGTH. PERFORMANCE.

Chin-up and pull-up performance is not just a test of strength. It is a test of mechanics, control, tissue tolerance, and intelligent progression. This global reference guide explains how vertical pulling works through the shoulder complex, trunk, grip system, and whole-body coordination, helping readers move from first hangs to strict reps, stronger variations, and long-term resilience.



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