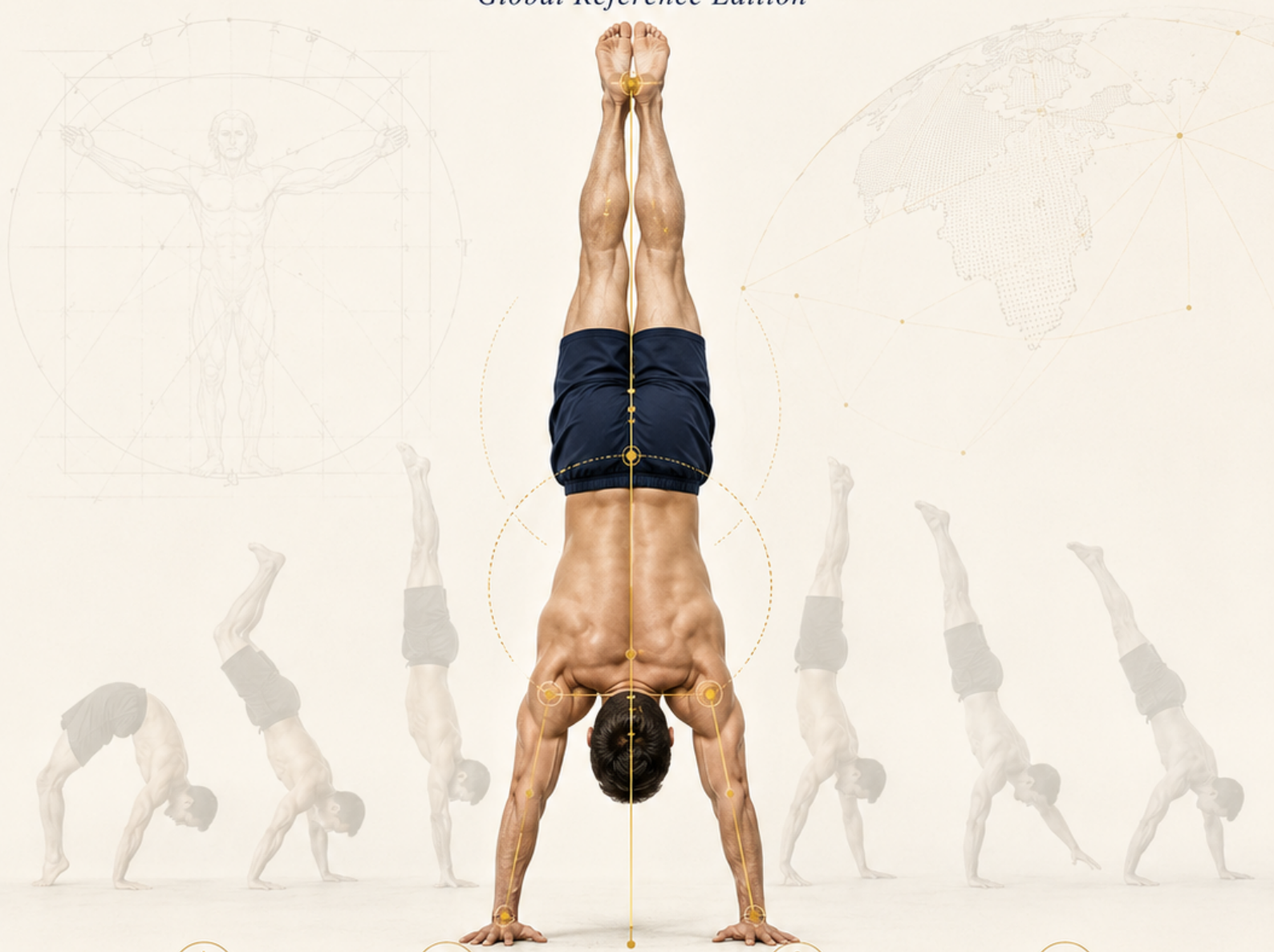
THE HANDSTAND & HANDSTAND WALK

A Complete Mechanical Decision Science

Global Reference Edition



LINE CONTROL
Balance & Alignment

SHOULDER ENGINE
Protraction & Stability

CORE INTEGRITY
Stiffness & Transfer

POWER IN MOTION
Step, Shift, Sustain

MMSx Authority Institute for
Movement Mechanics & Biomechanics Research

Dr Neeraj Mehta, PhD

THE HANDSTAND & HANDSTAND WALK

Complete Mechanical Decision Science - Global Reference Edition

Front Matter

Purpose, scope, reader map, scientific charter and complete part index

Field	Publication detail
Edition	A4 print-ready educational reference
Primary lens	Movement Decision Science for inversion skill
Audience	Athletes, coaches, clinicians, students and researchers
Scope	Handstand, handstand walk, press, push-up, assessment and return-to-skill

MMSx Authority Institute for Movement Mechanics & Biomechanics Research

Principal Author and Series Editor: Dr Neeraj Mehta, PhD

PUBLICATION RECORD

Authority, licence and citation note

PREFACE

Why this reference begins with mechanics

WHY THIS BOOK EXISTS

From impressive skill to readable movement problem

Handstand education is crowded with impressive demonstrations but often light on decision logic. Beginners are told to practise more. Advanced athletes are told to be tighter. Injured athletes are told to rest. None of those instructions is sufficient unless the coach can explain what the body is failing to regulate.

This book exists because the handstand is a rare skill where mobility, strength, balance, fear, exposure, anatomy and task rules are all visible in one movement. It is therefore an ideal model for Movement Decision Science.

The book is written to reduce guesswork. It separates line control from balance correction, passive mobility from loaded capacity, wall support from freestanding control, and static balance from inverted locomotion.

Why this book matters

The handstand becomes safer and more coachable when the athlete is not judged by appearance alone but assessed by load path, pressure control, phase failure and progression readiness.

WHO SHOULD READ THIS BOOK

Five reader lenses for one movement system

This reference is intentionally multi-level. A beginner can use it to understand what to practise first. A coach can use it to choose regressions and progressions. A clinician can use it to organise load tolerance and return-to-skill reasoning. A researcher or student can use it to define phases, variables and observable outcomes.

Reader	Primary use
Beginner athlete	Build a safe path from floor loading to wall support and freestanding balance.
Advanced athlete	Refine line, press, push-up and walking mechanics without relying only on volume.
Coach or trainer	Translate visible faults into mechanical decisions, cues and retests.
Clinician	Separate symptom-sensitive loading from skill errors and define graded exposure.
Student or researcher	Use phase language, pressure concepts and operational definitions for analysis.

The same page may serve different readers differently. The athlete reads the standard. The coach reads the decision. The clinician reads the tolerance boundary. The researcher reads the definition.

WHAT THIS BOOK HELPS WITH

Learning, coaching, assessment and progression

The book is designed to help with practical problems that appear repeatedly in handstand learning and coaching.

- Understanding why balance is corrected through pressure rather than by freezing the whole body.
- Choosing between wall holds, heel pulls, toe pulls, kick-up practice, line drills and walking drills.
- Identifying whether a visible fault began at the hands, wrists, shoulders, trunk, hips, legs or entry phase.
- Progressing from beginner loading to freestanding control, handstand walking, press work and handstand push-up preparation.
- Managing wrist, elbow, shoulder, neck and back tolerance with graded exposure rather than panic or denial.

What it does not do

The book does not promise a single best handstand. It teaches the reader to match the technique to the task, body, goal, surface, rules and tolerance state.

MOVEMENT DECISION SCIENCE

The MMSx reading model for inversion

Movement Decision Science reads every movement as a decision under mechanical constraint. In a handstand, the athlete must decide where to apply pressure, how to distribute load, how to organise joints, how to correct drift and when to stop or regress.

MDS question	Handstand interpretation
What is the loading event?	Bodyweight passes through the hand-wrist-shoulder-trunk line.
Where is the base?	The hand, finger and palm contact platform.
Where is the correction?	Pressure shift, wrist strategy, shoulder strategy, hip strategy and step replacement.
What is the risk boundary?	Pain, loss of control, failed exit, excessive fatigue or repeated compensation.
What is the progression decision?	Increase one variable only when the current standard is repeatable.

This is why the same athlete may need more wrist capacity in one phase, less kick-up momentum in another phase and better visual discipline during walking.

SCIENTIFIC CREDIBILITY CHARTER

Evidence language, limits and inference control

This edition separates direct evidence from applied inference. Direct handstand studies, gymnastics biomechanics, motor-control literature, injury and return-to-sport reasoning, and strength-conditioning principles do not carry the same weight. The book therefore treats evidence as a hierarchy, not decoration.

Evidence layer	Use in this book
Direct handstand biomechanics	Used for balance, wrist strategy, centre of pressure, phase and joint-demand reasoning.
Gymnastics and upper-extremity literature	Used for injury patterns, apparatus exposure and return-to-sport logic.
Motor learning research	Used for practice design, variability, feedback and skill acquisition.
Strength and conditioning principles	Used for dose, adaptation, fatigue and progressive overload.
Clinical reasoning	Used to define red flags, symptom monitoring and referral boundaries.

Credibility rule

Claims are written as educational reasoning, not as personal medical diagnosis. Where evidence is indirect, the book uses cautious language and mechanical logic rather than certainty.

SAFETY, SCOPE AND RESPONSIBILITY

Educational reference, not emergency or individual medical care

Inversion is not appropriate for every person on every day. A global reference must define its safety boundary clearly. This book is for education, coaching and professional reasoning. It is not a substitute for urgent care, diagnosis, rehabilitation prescription or clearance after injury or surgery.

- Stop and seek qualified assessment for suspected fracture, acute trauma, persistent neurological symptoms, dizziness, fainting, chest pain, uncontrolled blood pressure concerns, severe neck pain or progressive weakness.
- Do not use pain tolerance as the main progression standard. Pain behaviour, irritability and recovery response are part of the mechanical decision.
- When fatigue changes exits, hand placement, shoulder support or pressure control, the session has already changed from skill practice to risk exposure.

Safety principle

The safest progression is not the easiest progression. It is the progression that preserves the intended mechanical problem while keeping failure recoverable.

HOW TO USE THIS REFERENCE

Routes for study, coaching and clinical reasoning

The book can be read from front to back, but it is also built as a professional reference. Use the part covers for orientation, the phase atlas for diagnosis, the progression ladder for planning and the injury-return chapters for tolerance decisions.

Need	Where to start
I am new to handstands	Part I, Part V and Part VII.
I can wall-hold but cannot balance	Part II, Part IV and Part VI.
I want to handstand walk	Part VIII after passing wall, freestanding and exit standards.
I have wrist or shoulder symptoms	Part IX before increasing volume.
I coach or assess athletes	Part X plus the figure plates and phase audit tools.

The most useful reading pattern is: learn the model, test one standard, practise one correction, retest the same standard and only then add complexity.

QUICK PROGRESSION MAP

From first loading to advanced inversion

The handstand pathway is not a straight climb. Athletes often move forward in strength while moving backward in balance, or gain line control while temporarily losing confidence. The progression map therefore uses gates rather than fixed dates.

Gate	Pass standard
Floor loading	Hands tolerate repeated bodyweight exposure without symptom escalation.
Wall support	Athlete holds a clean line with controlled exit and repeatable breathing.
Balance correction	Athlete can correct small drift without panic or large hip movement.
Freestanding hold	Entry, catch, line, save and exit are repeatable across attempts.
Walking	Forward lean, weight shift, step replacement and recovery are controlled.
Advanced variants	Press, push-up and walk variations are added only after base standards remain stable.

Progression rule

Advance the problem, not the ego. Increase only one variable at a time: load, range, speed, time, instability, complexity or fatigue.

COMPLETE PART INDEX

Parts I-V

Page numbers refer to this expanded A4 print-ready edition with front matter inserted after the front cover.

Start	Part	Core focus
18	Part I - The Handstand as a Mechanical Decision	Why the skill is a load, line, pressure and decision problem.
56	Part II - The Physics Engine of Inversion	Gravity, centre of mass, centre of pressure, torque and walking mechanics.
86	Part III - The Human Machine	Hand, wrist, elbow, shoulder, trunk and muscle-function atlas.
118	Part IV - Balance Control and Skill Acquisition	Finger, shoulder, hip and visual strategies for freestanding control.
142	Part V - Mobility, Strength and Capacity Foundations	Wrist, shoulder, trunk and line capacity for safe progression.

Parts I-V build the conceptual engine: what the skill is, what physics demands, which anatomical structures solve the problem and which capacities must be prepared before advanced work.

COMPLETE PART INDEX

Parts VI-X

The second half turns the model into event analysis, progression, walking, return-to-skill and coaching apparatus.

Start	Part	Core focus
165	Part VI - The Complete Phase Atlas	Entry, catch, line, balance, hold, transfer and exit decisions.
191	Part VII - Beginner-to-Advanced Progression Ladder	Practical route from first inversion to freestanding control.
215	Part VIII - Handstand Walk	Forward lean, weight shift, hand replacement and locomotor rhythm.
238	Part IX - Pain, Injury and Return-to-Skill	Load-capacity reasoning, symptom monitoring and graded return.
260	Part X - Programming, Coaching and Reference Apparatus	Programming blocks, cue translation, assessment and video review.

Pagination note

Because this is a print-ready assembled edition, page starts may change if new chapters, figures or appendices are added later. Recheck pagination before ISBN registration or commercial print upload.

FIGURE AND TABLE SYSTEM

How visual plates support decision-making

The figure system is not decorative. It is a learning apparatus. Human-figure plates make the mechanical problem visible, while tables and decision boxes convert the visual observation into a coaching or progression decision.

Figure type	Purpose
Human-body instructional plates	Show body line, phase, pressure, support, fault and correction in coachable form.
Progression ladders	Place a drill inside a route rather than as an isolated exercise.
Fault comparison plates	Separate visible appearance from the first mechanical error.
Assessment figures	Standardise what the coach or clinician is checking.
Tables and boxes	Translate the figure into pass standards, regressions and risk logic.

The 98 human-figure plates should be read with the text beside them. A figure shows what to look at; the chapter explains what the observation means.

MMSx AUTHORITY INSTITUTE

Movement mechanics, biomechanics and decision-support education

MMSx Authority Institute for Movement Mechanics & Biomechanics Research is presented in this reference as an applied education and research platform focused on movement mechanics, biomechanics reasoning, load-capacity logic and translational coaching frameworks.

Its educational language emphasises force regulation, vector control, torque management, tissue tolerance, centre-of-pressure behaviour, neutral-zone reasoning, capacity-based progression and evidence-to-practice translation.

MMSx Authority statement

The institute role in this book is to provide the Movement Decision Science frame: do not merely describe movement; identify the mechanical decision, the load consequence and the next safe progression.

This publication is designed as open educational infrastructure for professionals who need clearer links between biomechanical theory and daily practice.

ABOUT THE PRINCIPAL AUTHOR

Dr Neeraj Mehta, PhD

Dr Neeraj Mehta, PhD, is the principal author and series editor of this reference. His professional work is centred on clinical and applied biomechanics, corrective exercise, movement mechanics, exercise progression and translational education for coaches, clinicians, athletes and students.

In this book, the author voice is intentionally practical: define the mechanical problem, protect the athlete, progress only what is ready and keep the explanation clear enough for coaching but strong enough for professional review.

Author note

The reader is invited to use this book as a working reference: mark it, test it, compare it with athletes, update it with better evidence and keep the central standard intact - movement advice must be mechanically clear, ethically safe and practically useful.

The front matter closes with one operating rule for the entire book: a handstand is not mastered when it looks impressive once; it is understood when the athlete can repeat the mechanical decision under changing load, fatigue, task and environment.

PART I

THE HANDSTAND AS A MECHANICAL DECISION

Line, load, balance and control.



JMMBS REFERENCE SERIES | MMSX DECADES LINE

The Handstand & Handstand Walk

A Complete Mechanical Decision Science - From First Wall Line to Freestanding Walking Balance

Global Reference Edition - Part I: The Handstand as a Mechanical Decision

FOUNDING STATEMENT

Biomechanics is not the description of muscles. It is the decision science of force vectors, torque, moment arms, base of support, centre of mass, sensory correction and tissue tolerance - and the handstand is one of the clearest human examples because the whole body must solve balance through the hands.

PUBLICATION RECORD

Field	Detail
Title	The Handstand & Handstand Walk: A Complete Mechanical Decision Science - Global Reference Edition
Series	JMMBS Reference Series - MMSx DECADES line
Issuing body	MMSx Authority Institute for Movement Mechanics & Biomechanics Research, Inc.
Principal author / editor	Dr Neeraj Mehta, PhD - Clinical Biomechanics Scientist; Founder & Principal Investigator, MMSx Authority
Language & style	British English - APA 7th edition referencing - senior research-institute register
Licence	Open access, Creative Commons Attribution 4.0 International (CC BY 4.0), proposed
Edition / year	Global Reference Edition - 2026
Part delivered	Part I complete: front matter, full book index and Chapters 1-8

EDITORIAL STATEMENT

Purpose, scope and credibility charter

This book is written as a comprehensive but usable reference for learning, coaching, analysing and progressing the handstand and handstand walk. It is designed for a beginner who wants a safe first route into inversion, a coach who must correct movement in real time, an athlete seeking high-level control, a clinician managing load tolerance, and a researcher who needs operational definitions rather than gym slogans.

The handstand is often taught as a shape: make a straight line, squeeze everything, push tall, or look at the floor. Those cues may help, but they are incomplete. A handstand is a mechanical decision. The athlete must decide where the pressure goes into the hand, how the wrist and fingers correct balance, how the shoulders transmit vertical force, how the ribs and pelvis organise the line, how the legs behave as a long lever, and how much training dose the wrist, elbow, shoulder, spine and nervous system can tolerate.

This volume does not claim that one handstand style is universally best. A straight-line gymnastics handstand, a curved-back circus handstand, a yoga handstand, a calisthenics handstand, a CrossFit handstand walk, and a handstand push-up all solve different mechanical problems. The right technique depends on the goal, body proportions, mobility, strength, surface, rules, fatigue, symptoms and training history.

This is an educational biomechanics and training reference, not a diagnosis document or emergency-care manual. Any athlete with chest pain, dizziness, fainting, unexplained neurological symptoms, acute wrist trauma, suspected fracture, severe shoulder pain, uncontrolled hypertension, recent surgery, known cervical spine risk, or persistent pain during loading should be evaluated by a qualified professional before inversion training.

MMSX CREDIBILITY RULE

Do not call a movement safe or unsafe without naming the load, position, person, dose and context. A handstand wall hold may be safe for one athlete and excessive for another. The decision is never the skill alone; the decision is the relationship between the skill and the human system performing it.

HOW TO USE THIS BOOK

Reader lenses

Lens	Reader	What they want	Where to start
BEGINNER	General trainee, yoga student, calisthenics beginner	Learn how to start without fear, wrist pain or random practice	Read Part I, Part V and Part VII.
COACH	Strength coach, gymnastics coach, calisthenics coach	Diagnose faults and progress the skill safely	Use the phase atlas, error maps and programming chapters.
CLINICIAN	Rehab professional, physiotherapist, corrective exercise specialist	Manage load tolerance, pain and return-to-inversion	Start with injury, wrist-shoulder load and return chapters.
ATHLETE	Gymnast, CrossFit athlete, calisthenics athlete, performer	Improve balance, control, endurance, walking and variations	Use balance-control, progression and advanced programming sections.
RESEARCHER	Educator, biomechanics scientist, PhD student	Define terms, map mechanisms and understand evidence limits	Use definitions, evidence map and reference apparatus.

EVIDENCE LANGUAGE

Direct handstand evidence is separated from gymnastics evidence, strength and motor-control evidence, clinical reasoning evidence and coaching field logic. This prevents over-claiming while keeping the book practical.

COMPLETE BOOK INDEX

Working index for the full reference book

The full book is designed as ten integrated parts. Part I is delivered in this file. Parts II-X will be created and released one at a time so each section can remain evidence based, polished and publication grade.

PART I - The Handstand as a Mechanical Decision

Chapter	Title
1	The one-sentence handstand
2	Twelve principles that explain almost everything
3	Handstand vocabulary, made exact
4	Clearing the floor: five persistent myths
5	The handstand is not only a strength skill
6	Wall handstand, freestanding handstand and handstand walk
7	The MMSx decision lens for inversion
8	How to read this book as a beginner, coach, clinician, athlete or researcher

PART II - The Physics Engine of Inversion

Chapter	Title
9	Gravity, line of load and the inverted body
10	Centre of mass and base of support
11	Centre of pressure: the hand as a balance platform
12	Force transmission from floor to wrist to shoulder
13	Moment arms at the wrist, elbow, shoulder and spine
14	Why the wrist behaves like an inverted ankle
15	Shoulder elevation as a vertical support strategy
16	Rib cage, pelvis and the line-control column
17	Hollow, straight and banana shapes explained mechanically
18	Torque leakage and why small shape errors become large balance errors
19	Friction, surface, hand size and pressure distribution
20	Work, energy and fatigue in static holds
21	Velocity and impulse in kick-up entry
22	Walking as repeated controlled loss of balance
23	Worked calculation I: bodyweight load through the hand
24	Worked calculation II: wrist moment and centre-of-pressure shift

PART III - The Human Machine

Chapter	Title
25	The hand: contact, friction and finger pressure
26	Wrist anatomy for handstand loading
27	Forearm flexors and extensors as pressure regulators
28	Elbow lockout, hyperextension and stability
29	Shoulder flexion, elevation and overhead tolerance
30	Scapular upward rotation and protraction

31	Serratus anterior as the hidden engine
32	Trapezius and the overhead support chain
33	Rotator cuff centration under vertical load
34	Rib cage mechanics and breathing upside down
35	Pelvic position and lumbar control
36	Hip line, leg tension and long-lever balance
37	Neck position and visual strategy
38	Anthropometry: arms, trunk, hands and body mass
39	Joint-by-joint atlas of the handstand
40	Why two athletes need different handstand styles
41	Muscle atlas: movers, stabilisers and regulators
42	Phase-by-phase muscle matrix

PART IV - Balance Control and Skill Acquisition

Chapter	Title
43	Balance as active correction, not stillness
44	Visual, vestibular and proprioceptive inputs
45	Finger-pressure strategy
46	Wrist strategy versus shoulder strategy
47	Hip strategy and why it is costly upside down
48	Micro-corrections and oscillation control
49	Expertise: how advanced athletes correct less but better
50	Fear, arousal and balance noise
51	Motor learning principles for inversion
52	Why wall time does not automatically create freestanding balance
53	Error detection and self-correction
54	The role of failed attempts
55	Internal versus external cueing
56	Blocked practice, variable practice and transfer
57	Fatigue as a balance disruptor
58	The nervous system under inversion
59	Building calm under the hands
60	Balance-control assessment sheet

PART V - Mobility, Strength and Capacity Foundations

Chapter	Title
61	Wrist extension capacity
62	Finger and palm loading tolerance
63	Elbow lockout control
64	Shoulder flexion mobility
65	Scapular elevation strength
66	Serratus anterior progression
67	Trunk hollow-body capacity
68	Hip compression and pike mobility
69	Hamstring mobility for press progressions
70	Toe point and line aesthetics
71	Loaded mobility versus passive range
72	Strength endurance for wall holds
73	Overhead pushing strength

74	Handstand push-up prerequisite strength
75	Press-to-handstand prerequisite strength
76	Capacity testing before progression
77	Daily preparation and tissue tolerance
78	Mobility that helps and mobility that distracts

PART VI - The Complete Phase Atlas

Chapter	Title
79	Phase model and event definitions
80	Phase 1: floor approach and hand placement
81	Phase 2: kick-up preparation
82	Phase 3: entry and momentum control
83	Phase 4: first contact and shoulder stacking
84	Phase 5: line organisation
85	Phase 6: balance correction
86	Phase 7: hold endurance
87	Phase 8: exit and fall management
88	Wall handstand phase model
89	Chest-to-wall phase model
90	Back-to-wall phase model
91	Freestanding handstand phase model
92	Tuck, straddle and split phase models
93	Press-to-handstand phase model
94	Handstand push-up phase model
95	Handstand walk phase model
96	Phase-to-fault diagnostic map
97	Where the handstand is won and lost
98	How fatigue changes every phase

PART VII - Beginner-to-Advanced Progression Ladder

Chapter	Title
99	How to use the progression ladder
100	Absolute beginner wrist preparation
101	Inversion confidence without load
102	Wall plank and pike loading
103	Box handstand progression
104	Wall walk progression
105	Chest-to-wall hold
106	Back-to-wall hold
107	Safe exit and cartwheel bail
108	Shoulder taps and weight shifts
109	Heel pulls and toe pulls
110	Freestanding kick-up practice
111	Five-second hold to thirty-second hold
112	Shape refinement ladder
113	Tuck, straddle and split variations
114	Press-to-handstand introduction
115	Handstand push-up introduction

116	Freestanding endurance progression
117	Combining holds, exits and re-entries
118	Testing readiness for handstand walk
119	Regression rules
120	Progression rules

PART VIII - Handstand Walk: From Balance to Locomotion

Chapter	Title
121	Why walking is not just holding plus steps
122	Controlled forward lean
123	Hand placement during walking
124	Shoulder shift and step timing
125	Pressure transfer from one hand to the other
126	Trunk stiffness during locomotion
127	Small steps versus long steps
128	Turning, stopping and restarting
129	Wall-assisted walking drills
130	Shoulder tap ladder
131	Partner-assisted walking
132	Line drills and lane drills
133	CrossFit handstand walk demands
134	Gymnastics and performance hand-walking demands
135	Fatigue, speed and technical breakdown
136	Common handstand-walk faults
137	Handstand-walk assessment sheet
138	Programming handstand-walk volume
139	Competition and event-specific demands
140	Advanced handstand-walk variations

PART IX - Pain, Injury and Return-to-Skill

Chapter	Title
141	How handstand injuries happen
142	Load-capacity model for inversion
143	Wrist pain patterns
144	TFCC and ulnar-sided wrist stress
145	Elbow pain and lockout stress
146	Shoulder pain and overhead loading
147	Neck and cervical safety
148	Low-back extension intolerance
149	Finger, palm and skin issues
150	Acute versus chronic warning signs
151	Red flags and referral logic
152	Return-to-wall ladder
153	Return-to-freestanding ladder
154	Return-to-walk ladder
155	Confidence after pain
156	Building long-term tissue tolerance

PART X - Programming, Coaching and Reference Apparatus

Chapter	Title
157	Principles of progression
158	Beginner eight-week on-ramp
159	Twelve-week freestanding plan
160	Intermediate balance block
161	Handstand-walk specialisation block
162	Press-to-handstand foundation block
163	Handstand push-up strength block
164	Integrating handstands with strength training
165	Integrating handstands with gymnastics
166	Integrating handstands with yoga
167	Integrating handstands with CrossFit
168	Youth and adolescent considerations
169	Masters athlete considerations
170	Coaching groups safely
171	Coaching online from video
172	Video-analysis checklist
173	Cue translation library
174	Troubleshooting compendium
175	Assessment sheets
176	Programme templates
177	Visual asset index
178	Master glossary and references

EVIDENCE MAP

Research foundation for Part I

Part I uses a layered evidence model. Direct handstand research is given the highest task specificity for balance-control claims, while gymnastics injury literature, strength-training literature and motor-learning literature support broader decisions about load, skill acquisition and tissue tolerance.

Evidence stream	How it is used in Part I	Representative sources
Direct handstand biomechanics	Centre of pressure, wrist strategy, centre of mass and coordination of inverted balance	Blenkinsop et al., 2017; Wyatt et al., 2021; Gautier et al., 2009
Press-to-handstand biomechanics	Transition mechanics, shoulder and hip moments, role of pike position and active flexibility	Prassas, 1988; Mizutori et al., 2021
EMG and apparatus studies	How support conditions change muscle activation and control demands	Kochanowicz et al., 2018; Kochanowicz et al., 2019
Skill and functional testing	Sport-specific readiness and physical ability measurement	Sleeper et al., 2016; Johnson et al., 2019
Injury prevention and return-to-sport	Load management, graded exposure and referral logic	Lauersen et al., 2014; Soligard et al., 2016; Hart, 2024

CREDIBILITY CAUTION

Where direct handstand evidence is limited, this book marks the claim as mechanically reasoned rather than proven. The goal is to be useful without pretending certainty where research is still developing.

PART I

The Handstand as a Mechanical Decision

Before a programme, before a wall drill and before any cue, the handstand must be defined precisely. The handstand is an inverted balance task in which the athlete supports body mass through the hands, controls the body's line over a small base of support, and regulates balance through pressure shifts, shoulder organisation, trunk stiffness and controlled correction.

A poor handstand is not simply weak. It may be a wrist-capacity problem, a shoulder-flexion problem, a fear problem, a motor-learning problem, a line-control problem, a dosage problem or an exit-skill problem. Part I builds the decision language so that every later drill has a reason.

Part I contains eight chapters: the one-sentence definition, twelve principles, exact vocabulary, myth removal, the support-line-correction model, task comparison, the MMSx decision lens and reader application. This is the conceptual operating system for the rest of the book.

PART I TASK

After reading this part, a coach should be able to observe a handstand attempt and classify the first limiting factor without guessing: base, stack, pressure, line, correction, exit or dose.

CHAPTER 1 | BEGINNER · COACH · RESEARCHER

The one-sentence handstand

A handstand is an inverted whole-body balance and load-transfer skill in which the athlete places the hands on the floor, stacks the wrists, elbows, shoulders, trunk, pelvis and legs against gravity, and uses the fingers, wrists, shoulders, trunk and visual-vestibular system to keep the centre of mass controlled over the base of support.

For a beginner, that sentence means: put the hands down, make a strong line, learn to exit safely and build tolerance gradually. For a coach, it means: assess the base, the line, the pressure strategy, the shoulder platform, the trunk column, the entry, the correction and the dose. For a clinician, it means: determine whether the tissues can tolerate repeated bodyweight loading in wrist extension and shoulder elevation. For an advanced athlete, it means: reduce unnecessary correction, refine the pressure map and convert static balance into controlled movement.

The handstand is often misunderstood because it looks still. In reality, it is never still. Even an expert handstand contains constant micro-corrections. The body behaves like a long inverted pendulum. When the body moves slightly beyond the fingers, the athlete must increase finger pressure or adjust the shoulder line. When the body falls back toward the heel of the hand, the athlete must reduce finger pressure, shift the shoulders, or change the body line. Balance is not the absence of movement; it is the skill of correcting movement before it becomes failure.

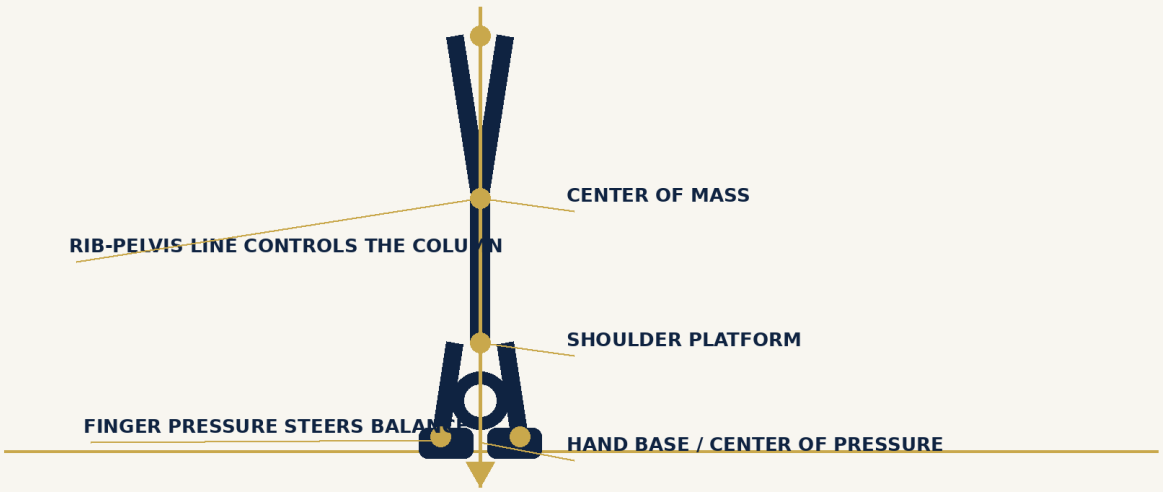
A handstand also changes the normal relationship between body and ground. In standing, the feet provide a large base and the ankles regulate balance. In a handstand, the hands provide a smaller and less familiar base, while the wrists and fingers must perform a role similar to the ankles and toes. This is why a strong athlete can still struggle: the problem is not only force production, but force regulation.

The MDS definition

Mechanical Decision Science defines the handstand as a decision system with five recurring variables: line, load, base, correction and tolerance. Line describes where the body mass is organised. Load describes how force is transmitted through the wrist, elbow, shoulder and trunk. Base describes the hand-floor interface. Correction describes the nervous system's pressure and position changes. Tolerance describes whether the athlete can recover from the dose.

- Position first: the hands, shoulders and trunk must create a shape that can accept load.
- Force second: the athlete must press the floor without collapsing the support chain.
- Correction third: the fingers, palm and shoulder line must control drift before it becomes a fall.
- Dose always: the same drill can be useful, useless or harmful depending on exposure and recovery.

HS-FIG-001 | THE INVERTED LOAD-TRANSFER SYSTEM



Caption: The handstand is a whole-body inverted load-transfer task; the hands form the base, the shoulders support the column, and small

Figure HS-FIG-001. The handstand is an inverted load-transfer system, not merely a pose.

KEY IDEA

A handstand is not holding yourself upside down; it is an inverted decision system of line, load, pressure, correction and tolerance.

EVIDENCE NOTE

Direct handstand research describes centre-of-mass and centre-of-pressure behaviour, wrist strategy, joint coordination and skill-level differences. These data support coaching that treats the handstand as a balance-control problem as much as a strength problem.

CREDIBILITY & CAUTION

Do not progress a learner because they are brave. Progress them because the wrist, shoulder, trunk, exit strategy and nervous system are ready for the next balance problem.

Twelve principles that explain almost everything

Most handstand problems are violations of a few mechanical principles. The details differ between a yoga practitioner, a gymnast, a calisthenics athlete, a CrossFit athlete and a beginner returning after wrist pain, but the main questions remain consistent: where is the centre of mass, where is the pressure under the hand, can the shoulders support the line, can the trunk prevent energy leakage, can the athlete correct balance without panic, and can the tissues tolerate the dose?

A handstand succeeds when the athlete can organise the body into a line, keep the line over the hand base, detect balance drift early, correct it with small pressure changes, and repeat the skill without exceeding tissue capacity. A handstand fails when one part of this chain is absent: the base is unstable, the stack is late, the fingers do not steer, the shoulders sink, the trunk leaks extension, the entry is too violent, or fatigue destroys the correction system.

The twelve principles are not motivational slogans. They are decision filters. When a coach sees a mistake, the first task is to classify which principle is being violated. That prevents over-cueing and allows the programme to target the actual bottleneck rather than the most obvious visual symptom.

Table 1.1. Twelve governing principles of the handstand

#	Principle	Mechanical meaning
1	Build the base first	The hands must create a stable, repeatable pressure platform.
2	Stack before strength	Wrist, elbow, shoulder, trunk and pelvis should be organised before long holds.
3	Fingers steer the line	Finger pressure helps prevent the body from falling over the front of the hand.
4	Shoulders are the pillars	Shoulder elevation and scapular control create the vertical support platform.
5	Ribs and pelvis control the column	Excessive rib flare or lumbar extension shifts mass and increases correction demand.
6	Small corrections beat large saves	Expert balance is quiet because corrections happen early.
7	Entry determines the hold	A wild kick-up forces the body to solve a balance problem it did not need to create.
8	The wall is a tool	Wall work builds line and confidence but must transfer to freestanding balance.
9	Exit skill is safety skill	A learner who cannot exit safely should not chase longer free holds.
10	Fatigue changes balance	Tired wrists, shoulders and trunk muscles increase sway and technical collapse.
11	Mobility must be loaded control	Passive range is not enough; the range must tolerate force.
12	Progression is a decision	The next drill should solve the current limiting factor, not satisfy ego.

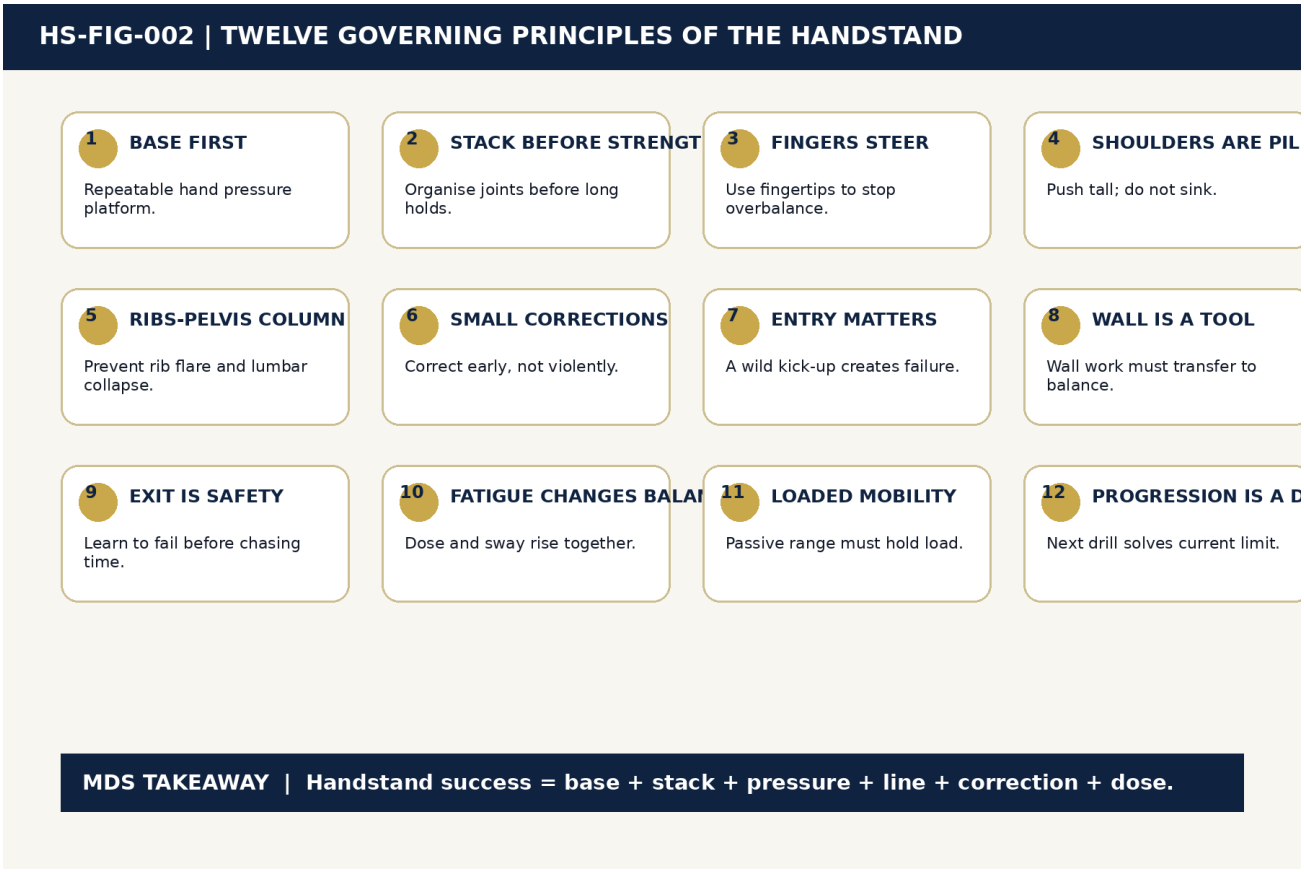


Figure HS-FIG-002. Most handstand errors are violations of a small number of mechanical principles.

KEY IDEA

Handstand success is built from base, stack, pressure, line, correction and dose.

EVIDENCE NOTE

Blenkinsop, Pain and Hiley reported that handstand balance relies heavily on a wrist strategy; Wyatt and colleagues later analysed centre-of-mass and centre-of-pressure interactions to identify control solutions associated with better handstand balance.

CREDIBILITY & CAUTION

A longer wall hold is not always a better handstand. If the athlete is collapsing into the lower back, dumping into the wrists or holding breath under fear, the time is teaching compensation.

Handstand vocabulary, made exact

Many handstand disagreements are language disagreements. One coach says push tall, another says open the shoulders, another says hollow, and the athlete receives slogans rather than targets. This book uses operational definitions so the same word means the same thing across coaching, clinical reasoning and research.

The most important vocabulary shift is this: a handstand is not only a position; it is a control task. The position is what the eye sees. The control task is what the nervous system solves. The reader should therefore treat each term as an observable decision variable. If a term cannot be seen, measured, coached or adjusted, it is not yet useful enough for this reference.

The vocabulary also prevents false precision. For example, 'straight line' is not a single universal shape. Some athletes need a slightly different shoulder angle, head position or pelvic strategy due to body proportions, mobility and task requirement. The operational term should describe what the athlete must control, not merely what the coach prefers aesthetically.

Table 1.2. Operational vocabulary used throughout this volume

Term	Working definition
Base of support	The area created by both hands in contact with the floor.
Centre of mass	The body's average mass location; in handstand it must be controlled over the hand base.
Centre of pressure	The point under the hands where the resultant ground reaction force acts.
Hand pressure map	The distribution of pressure through palm, fingers, thumb side and little-finger side.
Stack	A mechanically organised relationship between wrist, elbow, shoulder, trunk, pelvis and legs.
Shoulder elevation	The active push-tall action that lifts the body away from the floor and supports the line.
Hollow line	A controlled trunk shape that limits excessive rib flare and lumbar extension.
Banana handstand	A visibly arched handstand with increased lumbar extension and shoulder-angle compensation.
Kick-up	The entry strategy used to bring the legs overhead into handstand.
Bail	A safe exit from inversion, usually through a cartwheel-style or step-down strategy.
Balance correction	A small pressure, shoulder or body-line adjustment that prevents falling.
Handstand walk	A locomotor inversion skill where the athlete repeatedly shifts weight from one hand to the other while allowing controlled forward movement.

KEY IDEA

Precise language turns handstand coaching from cue repetition into mechanical decision-making.

EVIDENCE NOTE

Handstand studies commonly use terms such as centre of pressure, centre of mass, kinematics, kinetics, electromyography and coordination dynamics. The practical task is to translate those terms into coaching decisions without losing scientific meaning.

CREDIBILITY & CAUTION

Avoid perfect-line language with beginners if it creates fear or stiffness. A useful line is one the athlete can control, breathe in, exit from and repeat.

Clearing the floor: five persistent myths

Before handstand training becomes effective, several common myths must be removed. Myths are dangerous because they sound simple enough to teach, but they hide the true mechanical problem. A beginner who believes that strength alone will solve the handstand may keep adding shoulder work while ignoring finger pressure and exit skill. A coach who believes the wall teaches everything may create endurance without balance. An athlete who thinks pain is normal may turn a manageable load-tolerance warning into an injury.

Myth 1 - You must be very strong before starting

Strength helps, but the earliest progressions do not require advanced strength. A beginner can start with wrist preparation, quadruped loading, elevated pike holds, wall planks and safe exit practice. The goal is not to throw the body upside down on day one; the goal is to build the base and confidence.

Myth 2 - The wall teaches everything

The wall teaches orientation, shoulder endurance, line awareness and confidence. But the wall also hides balance errors. A learner can press into the wall for months and still lack finger-pressure correction. Wall work must eventually be paired with heel pulls, toe pulls, shoulder shifts, safe bails and freestanding attempts.

Myth 3 - A straight line is always best

A straight-line handstand is often desirable, especially in gymnastics-style aesthetics. But a slightly curved line may appear in circus balance, yoga contexts, calisthenics transitions or early learning. The question is not straight or wrong; the question is whether the line matches the goal and can be controlled without excessive tissue stress.

Myth 4 - Handstand walking is just moving the hands

Walking requires controlled forward imbalance, alternating single-arm support, shoulder shift, rhythm, trunk stiffness and step timing. A person may hold a handstand for twenty seconds yet still fail at walking because walking changes the task from static balance to locomotor balance.

Myth 5 - Pain is normal because handstands are hard

Effort is normal. Pressure is normal. Mild muscular fatigue may be normal. Sharp wrist pain, increasing shoulder pain, nerve symptoms, dizziness, neck pain or persistent symptoms are not signs of toughness. They are decision signals.

Table 1.3. Myth-to-mechanic translation

Myth	Mechanical replacement
You need elite strength first	You need graded support, confidence and tolerance first.
Wall practice equals balance	Wall practice must be converted into active pressure correction.
Straight line is always best	Line must match task, anatomy and control capacity.
Walking is just hand movement	Walking is controlled forward falling with alternating support.
Pain means weakness leaving the body	Pain is a load-tolerance signal requiring decision-making.

KEY IDEA

Good handstand coaching begins by removing myths that hide the real mechanical problem.

EVIDENCE NOTE

The direct evidence base shows that control strategies, wrist actions, coordination and apparatus conditions change handstand performance; therefore, a single universal slogan cannot explain the whole skill.

CREDIBILITY & CAUTION

A cue can be popular and still be wrong for a specific athlete. The coach must watch the result, not worship the phrase.

CHAPTER 5 | SUPPORT · LINE · CORRECTION

The handstand is not only a strength skill

Many strong athletes fail their first handstand because they try to overpower a balance problem. They press hard into the floor, stiffen the whole body, hold the breath and wait for stillness. But the handstand does not reward stiffness alone. It rewards organised stiffness plus sensitivity.

The handstand has three overlapping requirements. Support capacity means the wrist, elbow, shoulder and trunk can tolerate the load. Line capacity means the athlete can organise the body so the centre of mass stays near the base. Correction capacity means the athlete can detect drift and correct it before falling. A beginner often lacks all three. An intermediate athlete may have support capacity but poor correction. An advanced athlete may have support and correction but still lose line during fatigue or walking.

A clinician may see an athlete with adequate skill but reduced tissue capacity after pain. A coach must therefore ask which capacity is limiting the current attempt. The mistake is to prescribe more of the skill when the limiting factor is different from the skill itself.

The handstand also differs from ordinary upper-body strength because the shoulder works in a high-elevation position while the wrist is extended and loaded. A bench press, push-up or overhead press can help develop general strength, but none perfectly replicate the handstand's pressure map, visual inversion, hand-based balance correction or exit demand.

Table 1.4. Three-capacity model

Capacity	Main question	Common failure sign	First correction
Support capacity	Can the tissues tolerate the load?	Wrist pain, shoulder collapse, elbow discomfort	Reduce load, use elevated pike, shorten holds.
Line capacity	Can the body organise the stack?	Banana shape, rib flare, bent arms, head poking	Wall line, hollow drills, shoulder mobility.
Correction capacity	Can the athlete regulate balance?	Over-kicking, falling immediately, frozen fingers	Heel pulls, toe pulls, fingertip pressure drills.

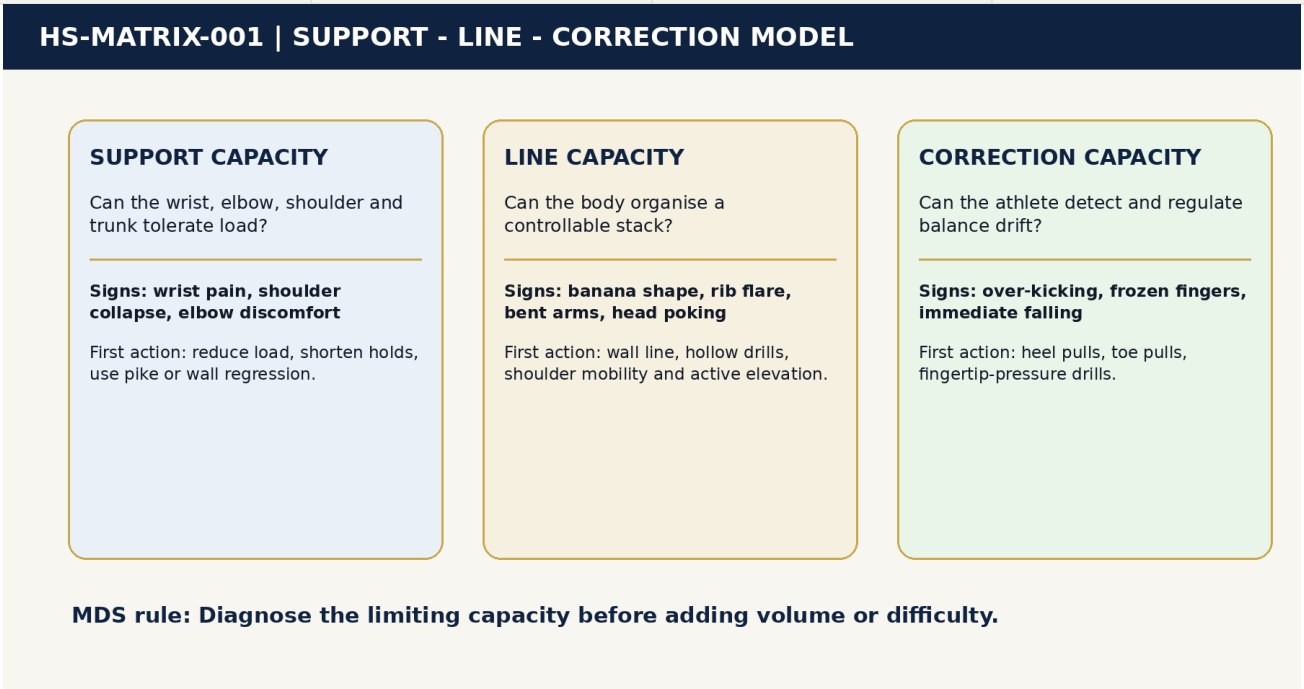


Figure HS-MATRIX-001. The three-capacity model separates support, line and correction so the coach can choose the right intervention.

KEY IDEA

Strength gets the athlete upside down; balance-control skill keeps the athlete there.

EVIDENCE NOTE

Electromyography research on handstands across apparatus indicates that hand support conditions alter muscle activation, and skill-level studies show more efficient coordination in experienced performers. This supports capacity-specific coaching rather than strength-only programming.

CREDIBILITY & CAUTION

Do not prescribe more shoulder strength when the actual limiting factor is fear, poor exit skill, wrist intolerance or lack of finger-pressure awareness.

CHAPTER 6 | TASK COMPARISON · PROGRESSION

Wall handstand, freestanding handstand and handstand walk

The wall handstand, freestanding handstand and handstand walk belong to the same family, but they are not the same task. A complete programme may use all three, but it should not use them at the same time for every athlete. The drill must match the mechanical problem being solved.

A wall handstand is a supported inversion. It can build load tolerance, shoulder endurance and line awareness. It is also useful for athletes who need confidence before freestanding attempts. However, the wall can reduce the demand for balance correction, especially if the athlete leans passively or lets the rib cage and pelvis collapse into extension.

A freestanding handstand is a static balance-control task. The athlete must keep the centre of mass over the hand base without external support. The fingers, palm, wrist, shoulders and trunk must make small corrections. Entry quality and exit skill become critical because each repetition is a live balance problem.

A handstand walk is a dynamic balance task. The athlete intentionally allows the centre of mass to move forward, then steps with the hands to keep the base under the moving body. This changes the problem from do not fall to fall slowly and catch yourself repeatedly.

Table 1.5. Three handstand tasks compared

Task	Main demand	Main benefit	Main limitation
Wall handstand	Load tolerance and line practice	Builds confidence and shoulder endurance	May hide poor balance correction.
Freestanding handstand	Static balance control	Builds pressure regulation and body-line control	Requires safe exit and repeated attempts.
Handstand walk	Dynamic balance and locomotion	Builds athletic coordination and inverted movement	Higher fatigue and wrist-shoulder volume demand.

KEY IDEA

Wall, freestanding and walking handstands are different mechanical problems; progress only when the current problem is solved.

EVIDENCE NOTE

Research separating static balance control, coordination, centre-of-pressure motion and apparatus-specific demands supports a task-specific view of handstand progressions.

CREDIBILITY & CAUTION

The handstand walk should not be used as a beginner test. It is a progression after the athlete can tolerate load, shift weight, exit safely and correct balance.

The MMSx decision lens for inversion

The MMSx decision lens asks one question before every drill: what mechanical problem are we solving right now? A handstand drill should not be chosen because it looks advanced. It should be chosen because it solves the athlete's current limiting factor.

This decision lens prevents random programming. If the athlete cannot place the hands without wrist discomfort, the next drill is not a freestanding kick-up. If the athlete collapses through the shoulders, the next drill is not a walking challenge. If the athlete has a beautiful wall line but no freestanding balance, the next drill must expose controlled balance correction.

The coach should write the decision on paper or in the session plan. The purpose of the drill should be visible. If a drill does not improve the target variable, it may still be useful later, but it is not the correct tool now. This is how the handstand becomes a teachable science rather than a collection of social-media progressions.

Table 1.6. MMSx handstand decision lens

Layer	Question	Example
Goal	What is the target skill?	First wall hold, freestanding hold, handstand walk, press, handstand push-up.
Base	Can the hands and wrists tolerate the position?	Wrist extension, finger pressure, palm loading.
Line	Can the body organise the stack?	Shoulder angle, ribs, pelvis, legs.
Support	Can the athlete push tall and maintain shoulder capacity?	Scapular elevation, serratus control, elbow lockout.
Correction	Can the athlete detect and correct drift?	Heel pulls, toe pulls, fingertip pressure.
Exit	Can the athlete fail safely?	Cartwheel bail, step-down, controlled return to wall.
Dose	How much volume can the tissues and nervous system tolerate?	Sets, hold time, attempts, frequency, fatigue signs.
Transfer	Does the drill carry over to the target?	Wall line to free balance, shoulder tap to walking.

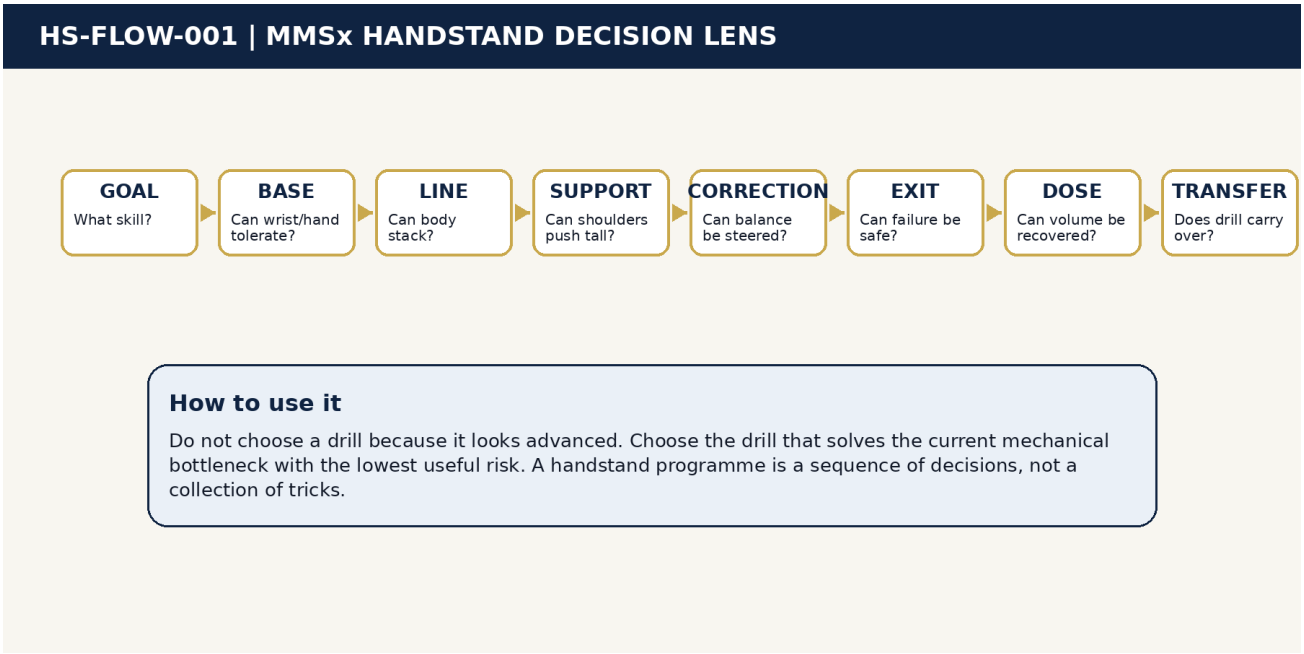


Figure HS-FLOW-001. The MMSx decision lens chooses drills by mechanical bottleneck, not by appearance.

KEY IDEA

The right drill is the one that solves the current mechanical bottleneck with the lowest useful risk.

EVIDENCE NOTE

Evidence-informed coaching combines movement observation, athlete history, pain response, performance data and research on motor control, strength and load management. The decision lens forces those streams to meet in the actual session.

CREDIBILITY & CAUTION

Progression is not proof of coaching quality. Sustainable progression is. A programme that creates fast skill gain but persistent wrist or shoulder irritation is mechanically incomplete.

CHAPTER 8 | READER LENSES · APPLICATION

How to read this book as a beginner, coach, clinician, athlete or researcher

The same handstand must be taught five different ways without contradiction. A beginner needs safety, confidence and simple steps. A coach needs fault recognition. A clinician needs tissue tolerance and referral logic. An athlete needs performance transfer. A researcher needs definitions and evidence boundaries. This book is layered so those readers can use the same science at the level that changes their decisions.

Beginner reading path

Read the plain-language openers, safety notes, progression ladders and quick-reference cards. Do not start with advanced variations. Your first goal is not a perfect handstand; it is safe loading, controlled wall work, a calm kick-up and a reliable exit.

Coach reading path

Use the phase atlas, diagnostic maps and cue translation library. Your job is to identify the first limiting factor. Do not add five cues when one mechanical correction would solve the movement.

Clinician reading path

Prioritise load tolerance, symptoms, tissue response and graded return. A handstand is a high-load wrist-extension and shoulder-elevation task. Return-to-skill must be built with exposure, not guessing.

Athlete reading path

Use the programming blocks, skill ladders and fatigue rules. Track hold time, number of clean entries, exit quality, wrist response, shoulder endurance and balance consistency.

Researcher reading path

Use the operational definitions, evidence map, glossary, visual index and reference apparatus. Treat the handstand as a model task for inverted balance, upper-limb load support and sensorimotor control.

Table 1.7. Reader lens map

Lens	Reader	What they want	Where to start
Beginner	General trainee	Safety, confidence and first progression	Part I, Part V, Part VII.
Coach	Trainer or gymnastics coach	Fault diagnosis and correction	Phase atlas, cue library, assessment sheets.
Clinician	Rehab professional	Load tolerance and return-to-skill	Pain, injury and return-to-skill sections.
Athlete	Gymnast, calisthenics or CrossFit athlete	Performance transfer and consistency	Programming, balance and walking sections.
Researcher	Educator or scientist	Definitions, evidence map and mechanisms	Operational definitions and reference apparatus.

KEY IDEA

A reference book must let different readers use the same science at different levels.

EVIDENCE NOTE

Handstand skill combines biomechanics, motor learning, tissue capacity, coaching communication and athlete psychology. No single evidence stream is enough alone.

CREDIBILITY & CAUTION

Simple explanations are not less scientific when they are mechanically accurate. Complex explanations are not useful when they cannot change a coaching decision.

PART I FIELD TOOLS

Quick-reference decision sheet

Problem seen	Likely category	First decision
Wrist pain during wall hold	Base / tissue tolerance	Reduce angle and load; assess wrist extension; shorten exposure.
Banana shape	Line control	Improve shoulder flexion, rib-pelvis control and wall line awareness.
Bent elbows	Support capacity or fear	Regress load, teach active push, assess elbow comfort.
Over-kicking	Entry control	Practise controlled kick-ups and wall stopping drills.
Cannot balance away from wall	Correction capacity	Add heel pulls, toe pulls and fingertip-pressure drills.
Falls dangerously	Exit skill	Teach cartwheel bail before more free attempts.
Can hold but cannot walk	Dynamic transfer	Add shoulder taps, weight shifts and controlled forward lean.
Pain increases session to session	Dose error	Reduce volume, increase recovery and reassess progression.

COACH'S ONE-CORRECTION RULE

In a live session, correct the first limiting factor before adding more cues. A beginner cannot process ten mechanical instructions while upside down. Choose the cue that changes the movement most safely.

TRANSITION TO PART II

Next part: The Physics Engine of Inversion

Part II will turn the language of Part I into physics. We will build the handstand from gravity, centre of mass, centre of pressure, base of support, wrist torque, shoulder moment, friction, surface behaviour, kick-up impulse and handstand-walk locomotion.

The reader will learn why a small movement of the centre of pressure can save a hold, why the wrist behaves like an inverted ankle, why shoulder elevation changes the support column, why handstand walking is repeated controlled loss of balance, and how to perform practical calculations for load, torque and work.

Part II should be created next as a standalone PDF/DOCX file and later merged into the full global reference edition.

REFERENCES

Part I seed reference list

Asseman, F., & Gahery, Y. (2005). Effect of head position and visual condition on balance control in inverted stance. Neuroscience Letters, 375, 134-137. https://doi.org/10.1016/j.neulet.2004.10.085

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018. https://doi.org/10.1098/rsos.161018

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140. https://doi.org/10.1016/j.humov.2008.05.003

Gautier, G., Thouvarecq, R., & Chollet, D. (2007). Visual and postural control of an arbitrary posture: The handstand. Journal of Sports Sciences, 25(11), 1271-1278. https://doi.org/10.1080/02640410601049144

Hart, E. (2024). Common upper extremity gymnastics injuries and gymnastic-specific return-to-play protocols. Journal of the Pediatric Orthopaedic Society of North America.

Johnson, A., Meador, M., Bodamer, M., Langford, E., & Snarr, R. L. (2019). Exercise technique: Handstand push-up. Strength & Conditioning Journal, 41(2), 119-123. https://doi.org/10.1519/SSC.0000000000000427

Kerwin, D. G., & Trewartha, G. (2001). Strategies for maintaining a handstand in the anterior-posterior direction. Medicine & Science in Sports & Exercise, 33(7), 1182-1188. https://doi.org/10.1097/00005768-200107000-00016

Kochanowicz, A., Niespodzinski, B., Marina, M., Mieszkowski, J., Biskup, L., & Kochanowicz, K. (2018). Relationship between postural control and muscle activity during a handstand in young and adult gymnasts. Human Movement Science, 58, 195-204. https://doi.org/10.1016/j.humov.2018.02.007

Kochanowicz, A., Niespodzinski, B., Mieszkowski, J., Marina, M., Kochanowicz, K., & Zasada, M. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research, 33(6), 1609-1618. https://doi.org/10.1519/JSC.0000000000002124

Lauersen, J. B., Bertelsen, D. M., & Andersen, L. B. (2014). The effectiveness of exercise interventions to prevent sports injuries: A systematic review and meta-analysis of randomised controlled trials. British Journal of Sports Medicine, 48(11), 871-877. https://doi.org/10.1136/bjsports-2013-092538

McDonald, M., Baker, J. S., Gu, Y., & Ugbolue, U. C. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living, 7, 1694648. https://doi.org/10.3389/fspor.2025.1694648

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joints moments profile during straight arm press to handstand in male gymnasts. PLoS ONE, 16(7), e0253951. https://doi.org/10.1371/journal.pone.0253951

Prassas, S. G. (1988). Biomechanical model of the press handstand in gymnastics. International Journal of Sport Biomechanics, 4(4), 326-341. https://doi.org/10.1123/ijsb.4.4.326

Sleeper, M. D., Kenyon, L. K., Elliott, J. M., & Cheng, M. S. (2016). Measuring sport-specific physical abilities in male gymnasts: The Men's Gymnastics Functional Measurement Tool. International Journal of Sports Physical Therapy, 11(7), 1082-1100.

Soligard, T., Schwellnus, M., Alonso, J. M., Bahr, R., Clarsen, B., Dijkstra, H. P., et al. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of

injury. British Journal of Sports Medicine, 50(17), 1030-1041. https://doi.org/10.1136/bjsports-2016-096581

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405. https://doi.org/10.1038/s41598-020-79730-z

Yeadon, M. R., & Trewartha, G. (2003). Control strategy for a hand balance. Motor Control, 7(4), 411-430. https://doi.org/10.1123/mcj.7.4.421

HS-FIG-001 | The One Sentence Handstand

FIGURE 1 | The One-Sentence Handstand



A handstand is an inverted whole-body balance skill in which the athlete stacks the body over the hands and maintains control through pressure, alignment and active support.

HS-FIG-002 | Plain Language Beginner Handstand

FIGURE 2 | Plain-Language Beginner Handstand



The beginner handstand starts with clear hand placement, a controlled kick-up and a stable stacked finish.

HS-FIG-003 | Wall Handstand Vs Freestanding Handstand Vs Handstand Walk

FIGURE 3 | Wall Handstand, Freestanding Handstand & Handstand Walk



Wall support builds line and confidence, freestanding balance builds control, and walking adds dynamic locomotion.

HS-FIG-004 | Support Line Correction Model

FIGURE 4 | The Handstand as a Support–Line–Correction Model



Good handstands depend on support capacity, line control and balance correction working together.

HS-FIG-005 | Good Kick Up Vs Uncontrolled Kick Up

FIGURE 5 | Good Kick-Up vs Uncontrolled Kick-Up



A good kick-up creates a manageable balance problem; an uncontrolled kick-up makes the catch harder and less repeatable.

HS-FIG-006 | Safe Bail Cartwheel Exit

FIGURE 6 | Safe Bail / Cartwheel Exit



A safe bail turns a lost handstand into a controlled cartwheel-style exit rather than a panic fall.

HS-FIG-007 | Straight Hollow And Banana Handstand Overview

FIGURE 7 | Straight, Hollow & Banana Handstand



Different body-line strategies change how the handstand is balanced and how load is distributed through the trunk and shoulders.

HS-FIG-008 | Foundational Beginner Setup Positions

FIGURE 8 | Foundational Beginner Setup Positions



Foundational setup positions teach loading, shoulder organisation and confidence before full inversion.

PART II

The Physics Engine of Inversion

Force, leverage, pressure and balance.

$$\tau = F \times d$$

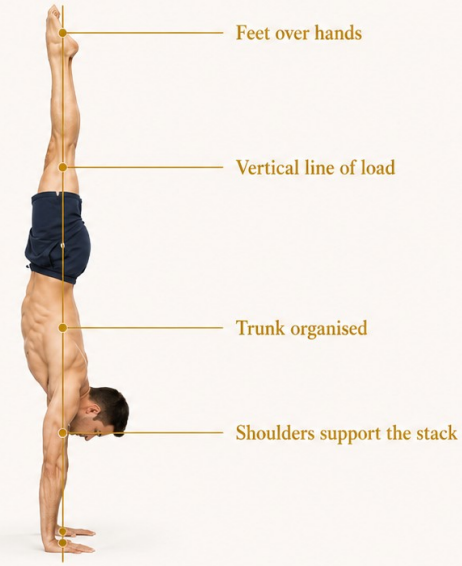
$$\sum M = 0$$



Chapter 9

Gravity, line of load and the inverted body

FIGURE 9 | Line of Load in the Handstand



In an organised handstand, the line of load passes from the floor through the hands and upward through the stacked body.

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

Gravity supplies the external demand; the athlete supplies organisation against that demand. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Load line	The bodyweight vector acts downward through the body centre of mass.	Teach the athlete to feel the line over the middle of the hand, not to chase a rigid picture.
Stack	Better stacking reduces unnecessary joint moments.	Correct the shoulder-rib-pelvis relationship before adding time.
Sway	Small deviations create corrective torque demands.	Coach early corrections rather than late saves.

KEY IDEA

The handstand begins when gravity becomes a line to organise, not a force to fear.

EVIDENCE NOTE

Direct handstand literature repeatedly uses centre of mass, centre of pressure, joint moments and balance control variables to describe the skill rather than only visual aesthetics.

CREDIBILITY & CAUTION

Do not call an arched handstand weak automatically. It may be a mobility compensation, a style choice, a fatigue response, or a balance strategy.

FIELD CHECK

Film from the side. Draw a vertical line through the mid-hand. Note where the shoulder, ribs, pelvis and feet fall relative to that line.

Chapter 10

Centre of mass and base of support in a handstand

FIGURE 10 | Centre of Mass over Base of Support



A handstand is balanced when the body's centre of mass is controlled over the base of support created by the hands.

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

The centre of mass must remain controllable over the hand-created base of support. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
COM too far forward	Athlete tips over toward the fingers.	Use fingertip pressure drills and reduce kick-up speed.
COM too far back	Athlete falls toward the wall/heels of the hand.	Use heel-pull drills and shoulder-opening cues.
Base too narrow	Rotational errors increase.	Use consistent hand width and stable finger spread.

KEY IDEA

Balance is the relationship between the body centre of mass and the hand base, not merely how long the athlete survives upside down.

EVIDENCE NOTE

Wyatt et al. investigated dynamic interactions between CoP and CoM during handstand balance, supporting a control-based reading of the skill.

CREDIBILITY & CAUTION

A large base does not fix poor control. Wider hands may increase confidence but can also change shoulder angle and line mechanics.

FIELD CHECK

Mark the hand outline with tape. Repeat 5 kick-ups. If the hand base changes every attempt, do not judge balance consistency yet.

Chapter 11

Centre of pressure: the hand as a balance platform

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

The handstand is steered by pressure, especially through the fingers and palm heel. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Finger-side CoP	Used to prevent overbalance.	Teach sustained fingertip pressure, not clawing panic.
Palm-heel CoP	Appears when the athlete underbalances.	Cue a gentle shoulder shift forward or reduce heel pressure.
Side-to-side CoP	Indicates rotational or single-hand asymmetry.	Check hand angle, elbow lockout and shoulder height.

KEY IDEA

The hand is a pressure map; balance improves when the athlete learns to steer that map.

EVIDENCE NOTE

Blenkinsop, Pain and Hiley compared standing and handstand balance and described a wrist-based strategy for handstand control, analogous in role to ankle strategy in standing.

CREDIBILITY & CAUTION

Fingers are steering tools, not brakes for violent saves. Excess gripping can increase forearm fatigue and worsen later attempts.

FIELD CHECK

Ask the athlete to lift the heels from a wall line using only finger pressure. If the movement is jerky, reduce hold time and train pressure sensitivity.

Chapter 12

Force transmission from floor to wrist to shoulder

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

Ground reaction force enters through the hands and must be transmitted through the wrists, elbows, shoulders and trunk. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Hand contact	Receives vertical GRF and pressure shifts.	Use full-hand contact and consistent finger spread.
Wrist	Accepts extension and moment demand.	Progress wrist loading gradually.
Shoulder	Acts as the main vertical support platform.	Push tall; avoid sinking into passive end range.
Trunk	Prevents energy leak from ribs and pelvis.	Use hollow-line control without breath locking.

KEY IDEA

Every handstand rep is a force-transmission event from the floor into the body.

EVIDENCE NOTE

Force-plate handstand and press-to-handstand studies provide a basis for interpreting vertical load, CoP movement, joint moments and timing.

CREDIBILITY & CAUTION

If the shoulder collapses, do not keep adding wrist drills. The load chain must be read joint by joint.

FIELD CHECK

Watch a wall hold for three collapse points: heel of palm overload, elbow softness and shoulder sinking. Fix the first visible leak.

Chapter 13

Moment arms at the wrist, elbow, shoulder and spine

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

A moment arm is the distance between the line of force and the joint axis; in handstands small distances matter. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Wrist moment	Affected by CoP position relative to wrist axis.	Teach pressure shifts and manage extension range.
Shoulder moment	Affected by shoulder angle and COM line.	Improve overhead stack and scapular elevation.
Spinal moment	Affected by rib flare, pelvis and leg line.	Coach rib-pelvis control and avoid uncontrolled banana shape.

KEY IDEA

A handstand fault becomes important when it increases the moment demand beyond the athlete's control or tolerance.

EVIDENCE NOTE

Prassas developed a biomechanical model of press handstand torque requirements, and later studies such as Mizutori et al. extended joint-moment analysis in skilled gymnasts.

CREDIBILITY & CAUTION

Moment-arm language is useful only when it changes a decision; do not overwhelm beginners with equations during early confidence practice.

FIELD CHECK

When a joint hurts, identify whether the load line has shifted farther from that joint before blaming weakness alone.

Chapter 14

Why the wrist behaves like an inverted ankle

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

During handstand balance, the wrist and fingers often perform the correction role that the ankle and toes perform in standing. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Standing	Foot and ankle regulate sway over a broad base.	Understand the analogy.
Handstand	Fingers and wrist regulate sway over a smaller hand base.	Train pressure precision.
Walking handstand	Hands repeatedly replace the base under a moving COM.	Train weight shifts before distance.

KEY IDEA

The wrist is the inverted ankle of the handstand, but it has less familiar tolerance and a smaller correction window.

EVIDENCE NOTE

Balance-control studies comparing standing and handstand support the concept of different joint strategies depending on orientation and support base.

CREDIBILITY & CAUTION

The analogy should not be overextended: the wrist has different anatomy, tissue tolerance and injury patterns than the ankle.

FIELD CHECK

Use a 0-10 pressure scale: 0 = no finger pressure, 10 = maximal gripping. Most control drills should live around 3-6, not 10.

Chapter 15

Shoulder elevation as a vertical support strategy

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

The shoulder complex is the main pillar between the floor and the body column. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Passive sink	Shoulders move toward ears without active support.	Teach active elevation and protraction.
Over-shrug with rib flare	Athlete gains height but loses trunk line.	Pair push tall with rib control.
Stable pillar	Scapulae upwardly rotate/protract and the trunk stays organised.	Progress hold time or balance challenge.

KEY IDEA

Push tall is not a slogan; it is the active organisation of the shoulder platform under bodyweight.

EVIDENCE NOTE

Handstand EMG and gymnastics apparatus studies indicate that muscle activity changes with support conditions and apparatus, reinforcing the need to train support specifically.

CREDIBILITY & CAUTION

More elevation is not always better if it is bought by spinal extension, breath holding or neck tension.

FIELD CHECK

During a wall hold, ask for a small “floor away” push without changing rib position. If ribs flare, the shoulder cue is leaking into the spine.

Chapter 16

Rib cage, pelvis and the line-control column

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

The trunk converts two hands and two legs into one controllable column. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Rib flare	Moves mass and encourages lumbar extension.	Use exhale-to-stack drills.
Posterior tilt excess	Can flatten too much and reduce shoulder access.	Use neutral hollow, not maximal tuck.
Coordinated column	Ribs, pelvis and legs organise around the load line.	Progress to free balance drills.

KEY IDEA

The handstand line is won in the ribs and pelvis as much as in the hands.

EVIDENCE NOTE

Radiographic work in gymnasts has examined sagittal alignment during handstand, supporting the need to treat spinal-pelvic organisation as a measurable component rather than a vague aesthetic.

CREDIBILITY & CAUTION

Do not force a single trunk shape on all bodies. The useful shape is the one that matches the goal and is repeatable without symptoms.

FIELD CHECK

Have the athlete breathe quietly in a chest-to-wall hold. If they lose the line when breathing, their line is being held by stiffness rather than control.

Chapter 17

Hollow, straight and banana shapes explained mechanically

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

Shape changes the location of mass and the correction demand. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Hollow	Ribs controlled, pelvis organised, shoulder angle available.	Useful for many gymnastics and calisthenics lines.
Straight	Minimal visible curve with stacked segments.	Aesthetic target when mobility and control allow.
Banana	Lumbar extension and/or shoulder compensation.	May be a beginner compensation or a style; analyse before correcting.

KEY IDEA

Shape matters because it moves mass and changes the control problem.

EVIDENCE NOTE

The 2025 systematic review of handstand biomechanics summarises a literature that includes joint angles, CoP, torques, velocities and EMG, showing that shape should be interpreted mechanically.

CREDIBILITY & CAUTION

Straight line obsession can create over-cueing. Correct the error only if it reduces control, safety or performance transfer.

FIELD CHECK

Use three photos: best wall line, best free hold, fatigued hold. The difference between them reveals the athlete's real capacity.

Chapter 18

Torque leakage and why small shape errors become large balance errors

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

Torque leakage means force is produced but not transmitted into the desired line or correction. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Bent elbows	Load leaks into elbow angle and shoulder collapse.	Regress and teach lockout with comfort.
Rib flare	Mass shifts and spine extends.	Use hollow-line preparation.
Soft shoulders	Vertical support shortens.	Train scapular elevation endurance.
Loose legs	Long levers become noisy.	Use toe point/leg squeeze only as much

		as needed.

KEY IDEA

Small errors matter when they lengthen moment arms, increase sway or make correction late.

EVIDENCE NOTE

Expertise-level handstand studies suggest that better performers organise coordination more effectively; this supports coaching toward quiet correction rather than heroic saving.

CREDIBILITY & CAUTION

Not every visible error deserves immediate correction. Pick the leak that changes safety or transfer first.

FIELD CHECK

Use the one-correction rule: in each set correct only the first leak that appears before balance is lost.

Chapter 19

Friction, surface, hand size and pressure distribution

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

The floor is part of the handstand system. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Low friction	Hands slide or fingers cannot steer.	Use a safer surface or reduce dynamic work.
High friction	Skin and wrist may be stressed during rotation.	Manage volume and hand care.
Small hand base	Less pressure surface.	Increase precision and avoid rushed walking volume.
Large hand base	More contact but not automatic	Maintain active pressure map.

	control.	

KEY IDEA

A handstand is never body-only; the surface changes the available mechanics.

EVIDENCE NOTE

Apparatus studies show that hand support conditions change muscle activity, supporting surface- and apparatus-specific interpretation of handstand loading.

CREDIBILITY & CAUTION

Chalk, mats, blocks and parallettes change the problem. Do not compare results across surfaces as if they were identical.

FIELD CHECK

Record surface, hand angle, hand width, wrist wraps, parallettes and chalk use in every serious assessment.

Chapter 20

Work, energy and fatigue in static holds

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

A static hold looks motionless but still consumes energy through constant correction and support. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Support fatigue	Shoulders sink, elbows bend.	Shorten holds; add support endurance.
Correction fatigue	Finger pressure becomes late/violent.	Use smaller sets with more rest.
Trunk fatigue	Ribs flare or pelvis drifts.	End the set before line collapse.

KEY IDEA

Static does not mean free; every second of a handstand has a metabolic and motor-control cost.

EVIDENCE NOTE

Fatigue is a known disruptor of movement control in sport and should be interpreted as a change in both tissue capacity and skill quality.

CREDIBILITY & CAUTION

Long holds that teach collapse are not endurance training; they are compensation rehearsal.

FIELD CHECK

Stop a technical hold at the first repeated line collapse, not at the first fall. Quality fatigue arrives before failure.

Chapter 21

Velocity and impulse in kick-up entry

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

The entry creates the initial balance problem. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Too much impulse	Athlete overshoots and saves with fingers or wall impact.	Reduce kick height; use wall target.
Too little impulse	Athlete cannot stack over hands.	Use progressive kick-up and leg-drive timing.
Inconsistent impulse	Every attempt starts with a different problem.	Standardise hand placement and kick rhythm.

KEY IDEA

A handstand hold begins before the feet leave the floor.

EVIDENCE NOTE

Press-to-handstand and handstand kinematic studies reinforce that timing, joint position and velocity profiles are central to skilled inversion.

CREDIBILITY & CAUTION

Beginners often need less courage and more repeatable entry mechanics.

FIELD CHECK

Count clean entries, not only hold time. A session with 20 calm entries may be more valuable than one lucky 20-second save.

Chapter 22

Walking as repeated controlled loss of balance

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

Handstand walking converts static balance into locomotor balance. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Forward lean	COM moves ahead of the base.	Teach controlled lean, not falling panic.
Hand step	New hand contact replaces the base.	Use shoulder taps and small step drills.
Rhythm	Corrections become cyclical.	Train short lanes before speed.
Fatigue	Step size and shoulder support degrade.	Cap distance by quality.

KEY IDEA

Handstand walking is controlled falling plus base replacement.

EVIDENCE NOTE

Although direct handstand-walk research is limited, the mechanics are consistent with dynamic balance principles and handstand CoM-CoP control evidence.

CREDIBILITY & CAUTION

Do not progress to walking simply because the athlete can hold on the wall. Walking adds single-arm support, fatigue and forward momentum.

FIELD CHECK

Before distance goals, test 10 alternating shoulder taps with quiet rib-pelvis control and no wrist pain.

Chapter 23

Worked calculation I: bodyweight load through the hands

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

Simple calculations make coaching decisions clearer when their limits are stated. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Bodyweight force	mass x 9.81 m/s^2.	80 kg = about 785 N.
Two-hand quiet hold	Each hand may average about half total vertical load.	About 392 N per hand in a symmetrical hold.
Asymmetry	A 55/45 split changes loading meaningfully.	Right 432 N, left 353 N in this example.
Dynamic entry	Acceleration can increase transient forces.	Treat kick-ups and walks as higher demand than quiet holds.

KEY IDEA

A quiet handstand can load each hand with hundreds of newtons before dynamic correction is added.

EVIDENCE NOTE

Force-platform studies in gymnastics make it appropriate to discuss vertical GRF and load distribution, while recognising that simplified field calculations are not full inverse dynamics.

CREDIBILITY & CAUTION

These calculations are estimates for education. They do not measure tendon, cartilage, ligament or nerve stress.

FIELD TOOL

Calculation: Bodyweight force = body mass x 9.81. Estimated per-hand force = bodyweight force / 2, adjusted for visible asymmetry.

Chapter 24

Worked calculation II: wrist moment and centre-of-pressure shift

BEGINNER	COACH	CLINICIAN	ATHLETE	RESEARCHER

A small CoP shift can change the wrist moment even when bodyweight is unchanged. In the MMSx model, a handstand is read first as a physics problem and only second as a shape. The athlete is not simply upside down; the body is a tall inverted column that must keep gravity, pressure and joint torque organised over a small hand base.

The practical coaching question is: where is the line of load, and what must the athlete do to keep that line controllable? A technically attractive position can still be a poor decision if it creates excessive wrist moment, shoulder collapse, lumbar extension, fear or rapid fatigue.

The professional standard is to move from observation to mechanism. Instead of saying "the line is bad", the coach identifies whether the error came from hand pressure, wrist angle, shoulder elevation, rib-pelvis control, kick-up velocity, surface friction or insufficient recovery between attempts.

Mechanical decision table

Variable	Mechanical meaning	Coaching decision
Force	Per-hand vertical force in the example = 392 N.	Estimate from bodyweight and symmetry.
Moment arm	CoP 4 cm in front of wrist axis = 0.04 m.	Measure or estimate from video/pressure mat.
Moment	392 x 0.04 = 15.7 N m.	A simplified external moment demand.
Coaching use	Reduce excessive CoP excursion or	Use pressure drills and volume

	build tolerance gradually.	control.

KEY IDEA

In handstand mechanics, distance matters as much as load.

EVIDENCE NOTE

CoP-based handstand research supports the coaching value of pressure-position thinking, especially for wrist strategy and balance correction.

CREDIBILITY & CAUTION

The model ignores three-dimensional joint axes, shear, tissue properties and acceleration; use it as a coaching lens, not a diagnostic device.

FIELD TOOL

Track three variables together: wrist symptoms, hold duration and visible CoP strategy. Pain with increasing finger-side pressure suggests dose or tolerance review.

PART II FIELD AUDIT SHEET

Use this before progressing to Part III anatomy and muscle analysis

Physics audit

Item	Pass standard	Action if not passed
Hand base repeatability	Same hand width/angle in 4 of 5 attempts	Standardise base and reduce entry speed
COM line	Shoulder/ribs/pelvis remain controllable over mid-hand	Use wall-facing line drill and heel-pulls
Pressure strategy	Athlete can shift between finger and palm pressure calmly	Use low-volume CoP drills
Wrist moment tolerance	No increasing wrist symptoms during or 24 hours after load	Reduce volume or wrist extension demand
Kick-up impulse	Entry is repeatable without wall crash or panic save	Train low kicks and marked target
Walking readiness	Shoulder taps are quiet and pain-free	Delay walking volume

REFERENCES FOR PART II

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018. https://doi.org/10.1098/rsos.161018

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140.

Kochanowicz, A., Niespodzinski, B., Mieszkowski, J., Marina, M., & Kochanowicz, K. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research, 33(6), 1609-1618.

MacDonald, M., et al. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living.

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joint moments profile during straight arm press to handstand in male gymnasts. PLOS ONE, 16(7), e0253951. https://doi.org/10.1371/journal.pone.0253951

Prassas, S. G. (1988). Biomechanical model of the press handstand in gymnastics. International Journal of Sport Biomechanics, 4(4), 326-341.

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405. https://doi.org/10.1038/s41598-020-79730-z

Hall, S. J. (2022). Basic biomechanics (9th ed.). McGraw Hill.

Hamill, J., Knutzen, K. M., & Derrick, T. R. (2022). Biomechanical basis of human movement (5th ed.). Wolters Kluwer.

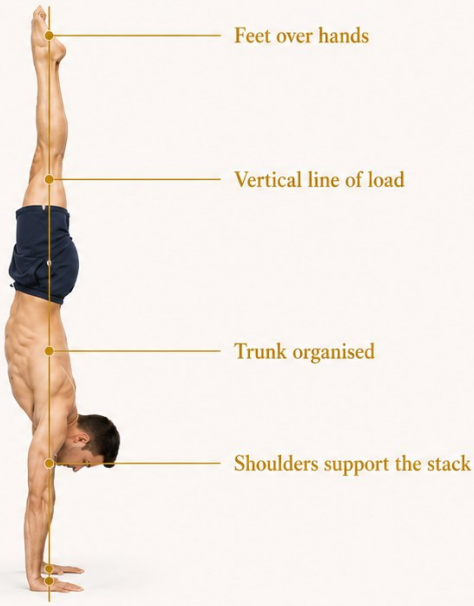
Winter, D. A. (2009). Biomechanics and motor control of human movement (4th ed.). Wiley.

Enoka, R. M. (2015). Neuromechanics of human movement (5th ed.). Human Kinetics.

Soligard, T., Schwellnus, M., Alonso, J. M., Bahr, R., Clarsen, B., et al. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of injury. British Journal of Sports Medicine, 50(17), 1030-1041.

HS-FIG-009 | Line Of Load In The Handstand

FIGURE 9 | Line of Load in the Handstand



In an organised handstand, the line of load passes from the floor through the hands and upward through the stacked body.

HS-FIG-010 | Centre Of Mass Over Base Of Support

FIGURE 10 | Centre of Mass over Base of Support



A handstand is balanced when the body's centre of mass is controlled over the base of support created by the hands.

HS-FIG-011 | Centre Of Pressure And Finger Pressure Control

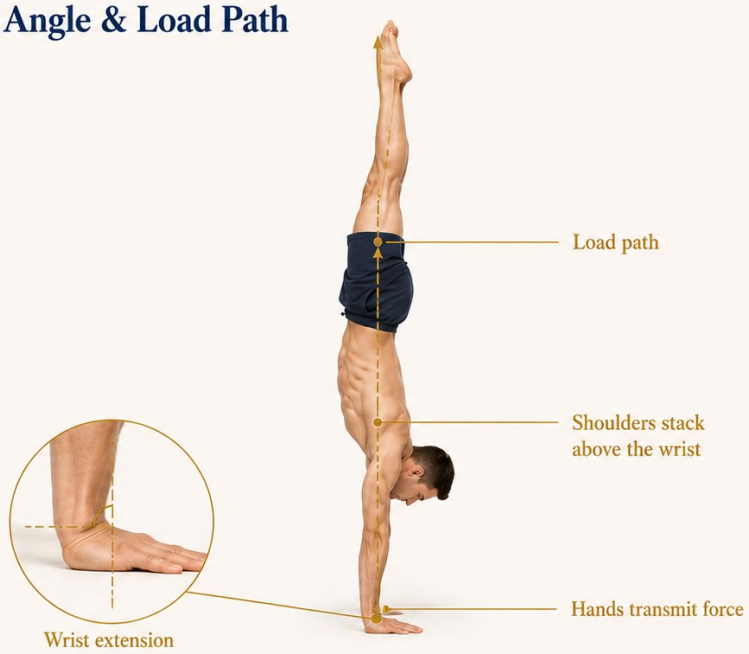
FIGURE 11 | Centre of Pressure & Finger-Pressure Control



In a handstand, balance is steered by subtle shifts in pressure through the fingers and palm while the whole body remains stacked over the hands.

HS-FIG-012 | Wrist Angle And Load Path

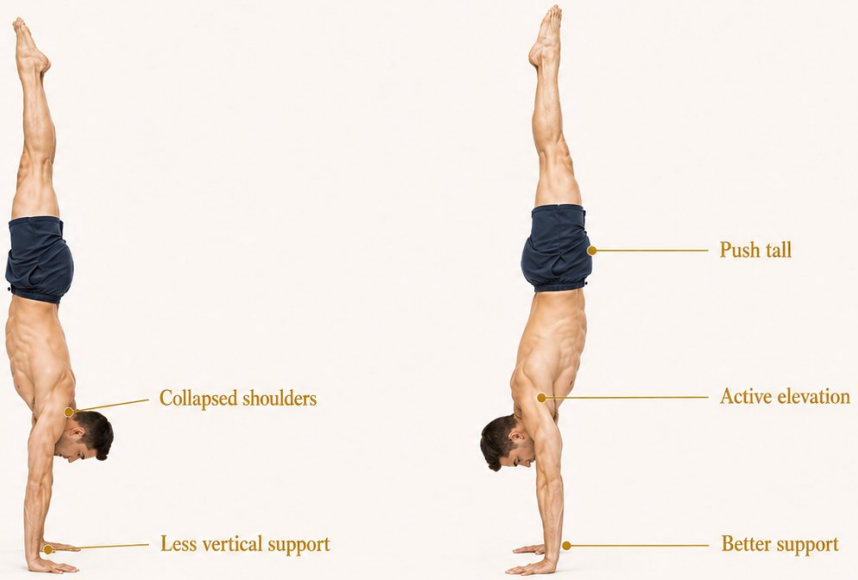
FIGURE 12 | Wrist Angle & Load Path



The handstand places the wrist in substantial extension, and the load path travels from the floor through the hands into the stacked upper limb and trunk.

HS-FIG-013 | Shoulder Elevation As Vertical Support

FIGURE 13 | Shoulder Elevation as Vertical Support



Vertical support improves when the athlete actively elevates through the shoulders rather than sinking into a collapsed overhead position.

HS-FIG-014 | Hollow Line Versus Rib Flare

FIGURE 14 | Hollow Line versus Rib Flare



Good trunk organisation keeps the ribs controlled and the line efficient; rib flare leaks extension and makes the handstand harder to control.

HS-FIG-015 | Kick Up Entry Mechanics

FIGURE 15 | Kick-Up Entry Mechanics



A good kick-up is a controlled transition from the floor to overhead balance rather than a rushed jump into inversion.

HS-FIG-016 | Walking As Controlled Forward Fall

FIGURE 16 | Walking as Controlled Forward Fall



Handstand walking begins by leaning the body forward in a controlled way and placing the first hand step to prevent a fall.

HS-FIG-017 | Handstand Moment Arms At Wrist Shoulder And Trunk

FIGURE 17 | Handstand Moment Arms at Wrist, Shoulder & Trunk



Small changes in alignment alter the moment arms at the wrist, shoulder and trunk and therefore change the torque demand of the handstand.

HS-FIG-018 | Pressure Shift For Front Fall And Back Fall Correction

FIGURE 18 | Pressure Shift for Front-Fall & Back-Fall Correction



Different pressure shifts are used to correct front-fall and back-fall tendencies during a handstand.

PART III

THE HUMAN MACHINE

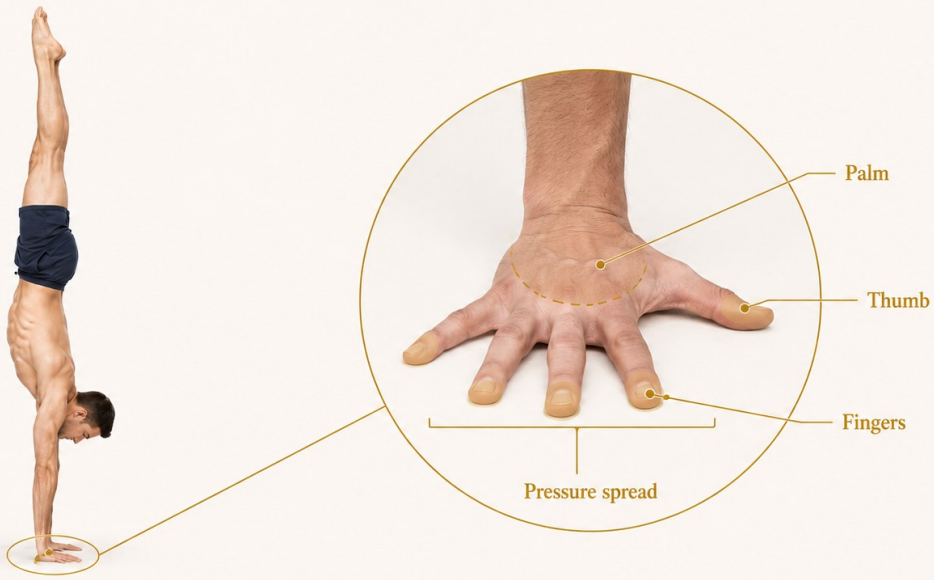
Wrist, shoulder, trunk and line-specific anatomy.



Chapter 25

The hand: contact, friction and finger pressure

FIGURE 19 | Hand Contact Platform



The hand contact platform distributes pressure through the palm, fingers and thumb and provides the sensory and mechanical base for balance.

COACH	CLINICIAN	ATHLETE	RESEARCHER

The hand is the only body part in contact with the floor during a standard handstand. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Fingers	Increase pressure to oppose overbalance.	Train gentle sustained pressure, not clawing.
Palm heel	Receives underbalance and baseline support.	Keep full-hand contact without dumping.
Thumb side	Helps resist rotation and hand collapse.	Cue spread and root through thumb mound.
Little-finger side	Completes the lateral base.	Check if athlete rolls out or twists.

KEY IDEA

The hand is a sensory-force platform, not a passive block.

EVIDENCE NOTE

Handstand balance research supports reading the hand as a CoP control surface, especially when wrist strategy is dominant.

CREDIBILITY & CAUTION

Sore skin and sore joints are different problems. Do not solve pressure-map errors with pain tolerance language.

FIELD CHECK

Dust hands lightly with chalk and inspect pressure marks after a hold. Uneven marks can guide hand-contact coaching.

Chapter 26

Wrist anatomy for handstand loading

FIGURE 20 | Wrist Extension Loading Positions



Wrist loading rises from pike-based preparation to wall-supported inversion and then to full freestanding handstand work.

COACH	CLINICIAN	ATHLETE	RESEARCHER

The wrist must tolerate loaded extension while allowing pressure shifts. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Extension range	Needed for palm contact and line.	Build loaded range gradually.
Compression tolerance	Carpal surfaces accept bodyweight forces.	Use progressive loading and rest.
Ulnar side	May become irritated with rotation/extension.	Monitor TFCC-type symptoms and refer when needed.
Wraps/parallettes	Change wrist angle and pressure demands.	Use as tools, not permanent avoidance unless clinically needed.

KEY IDEA

Wrist capacity is a gatekeeper for handstand volume.

EVIDENCE NOTE

Gymnastics injury literature frequently highlights upper-extremity loading concerns; handstand training should therefore use graded exposure rather than random volume.

CREDIBILITY & CAUTION

Persistent sharp pain, swelling, loss of grip, clicking with pain or ulnar-sided symptoms should not be trained through.

FIELD CHECK

Record pain before, during and 24 hours after loading. Progress only when symptoms stay stable or improve.

Chapter 27

Forearm flexors and extensors as pressure regulators

COACH	CLINICIAN	ATHLETE	RESEARCHER

Forearm muscles regulate finger pressure, wrist position and fine correction. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Finger flexors	Create steering pressure.	Train endurance and sensitivity.
Wrist extensors	Support wrist position and control return.	Avoid sudden volume spikes.
Pronation/supination control	Stabilises the hand base.	Check hand angle and rotation.
Fatigue sign	Late, jerky corrections.	Shorten sets before technique becomes violent.

KEY IDEA

Forearm strength must become pressure intelligence.

EVIDENCE NOTE

EMG and apparatus studies indicate that hand support conditions change the muscular solution of the handstand.

CREDIBILITY & CAUTION

Forearm pump is not proof of useful training if it removes balance sensitivity.

FIELD CHECK

Use 5 x 10-second pressure holds instead of one 50-second fatigue hold when teaching finger steering.

Chapter 28

Elbow lockout, hyperextension and stability

COACH	CLINICIAN	ATHLETE	RESEARCHER

The elbow transmits load between the wrist and shoulder. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Soft elbow	Energy leak and support loss.	Reduce load and teach active straight arm.
Comfortable lockout	Stable, repeatable load transfer.	Progress duration.
Hyperextension	May be normal anatomy but requires control.	Strengthen around end range; avoid passive hanging into joint.
Painful lockout	Possible overload or tissue issue.	Regress and assess/refer if persistent.

KEY IDEA

The best elbow position is not just straight; it is straight under active control.

EVIDENCE NOTE

Handstand and press-to-handstand mechanics rely on straight-arm support; joint moments and alignment must be interpreted with individual elbow anatomy.

CREDIBILITY & CAUTION

Do not force a naturally hyperextending elbow into an arbitrary visual line if it creates pain or instability.

FIELD CHECK

From a side video, identify whether elbow softness appears at entry, hold, fatigue or exit. The timing reveals the cause.

Chapter 29

Shoulder flexion, elevation and overhead tolerance

COACH	CLINICIAN	ATHLETE	RESEARCHER

The shoulder must combine range, strength and control in a high-elevation position. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Limited flexion	Athlete compensates with rib flare/banana shape.	Develop shoulder flexion and wall line.
Weak elevation	Athlete sinks toward floor.	Use scapular push and pike support work.
Painful overhead	Load intolerance or pathology may be present.	Regress and use clinical reasoning.
Strong overhead	Line remains tall under fatigue.	Progress to free balance and walking.

KEY IDEA

The shoulder is the main vertical pillar of the handstand.

EVIDENCE NOTE

Kochanowicz et al. reported apparatus-dependent muscle activity in handstands, supporting the specificity of shoulder and upper-extremity loading contexts.

CREDIBILITY & CAUTION

Overhead mobility without load tolerance is not enough; load tolerance without line control is not enough either.

FIELD CHECK

Compare shoulder flexion standing, wall-facing hold and freestanding attempt. The gap shows whether the issue is range, load or fear.

Chapter 30

Scapular upward rotation and protraction

COACH	CLINICIAN	ATHLETE	RESEARCHER

The scapula provides the moving platform for overhead support. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Upward rotation	Positions glenoid for elevation.	Cue push tall and train wall slides/pike work.
Protraction	Creates reach and support.	Avoid passive retraction under load.
Depression collapse	Shoulders sink.	Regress and build active elevation endurance.
Asymmetry	One shoulder lower or winging.	Assess serratus/trap control and fatigue.

KEY IDEA

Scapular control is the hidden architecture of the handstand line.

EVIDENCE NOTE

General shoulder biomechanics literature supports the role of scapular upward rotation and protraction in overhead function; handstand-specific EMG adds task specificity.

CREDIBILITY & CAUTION

Cueing “shoulders down” from upright lifting can be mechanically wrong in handstand support.

FIELD CHECK

Ask for a 2-cm extra push from the floor in a wall hold. If one scapula cannot follow, that side needs support-control work.

Chapter 31

Serratus anterior as the hidden engine

COACH	CLINICIAN	ATHLETE	RESEARCHER

Serratus anterior helps protract and upwardly rotate the scapula during overhead support. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Underactive serratus pattern	Winging, sinking or rib flare.	Use wall slides, scapular push-ups, pike plus drills.
Good serratus control	Shoulders stay tall and broad.	Progress balance challenge.
Fatigue	Loss of protraction under longer holds.	Use shorter quality sets.
Integration	Serratus must coordinate with traps and trunk.	Avoid isolated work only.

KEY IDEA

Serratus anterior turns shoulder strength into a usable handstand platform.

EVIDENCE NOTE

Handstand EMG findings and overhead biomechanics both support attention to scapular support muscles rather than only deltoids and triceps.

CREDIBILITY & CAUTION

Do not diagnose serratus weakness from appearance alone; retest after fatigue, cueing and trunk correction.

FIELD CHECK

Use a wall-facing hold and ask the athlete to spread the shoulder blades while keeping ribs quiet.

Chapter 32

Trapezius and the overhead support chain

COACH	CLINICIAN	ATHLETE	RESEARCHER

The trapezius coordinates scapular upward rotation, elevation and stability. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Upper trapezius	Contributes to elevation/upward rotation.	Use without neck clenching.
Lower trapezius	Supports upward rotation and posterior tilt.	Train with controlled overhead patterns.
Middle trapezius	Helps control scapular position.	Avoid excessive retraction in handstand.
Coordination	Works with serratus.	Train integrated support.

KEY IDEA

Trapezius is not the enemy of the neck; uncoordinated tension is.

EVIDENCE NOTE

Overhead shoulder models and handstand apparatus EMG studies support treating the scapular muscles as a coordinated system.

CREDIBILITY & CAUTION

Neck tension during handstands may be fear, vision strategy, breathing or scapular fatigue, not simply tight upper traps.

FIELD CHECK

Watch the neck during a push-tall cue. If the athlete grimaces or shortens the neck, reduce intensity and retrain elevation calmly.

Chapter 33

Rotator cuff centration under vertical load

COACH	CLINICIAN	ATHLETE	RESEARCHER

The rotator cuff helps centre the humeral head while larger muscles create support. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Centration	Maintains joint relationship under load.	Use low-noise shoulder control drills.
Fatigue	May produce wobble or pain.	Manage volume.
Compensation	Deltoid/pec dominate while cuff cannot stabilise.	Regress overhead load.
Return after pain	Requires graded exposure.	Use symptom-led progressions.

KEY IDEA

Rotator cuff work in handstand training is about joint control under vertical load, not only band exercises.

EVIDENCE NOTE

Gymnastics return-to-play and shoulder literature support careful management of upper-extremity loading when symptoms exist.

CREDIBILITY & CAUTION

Band external rotations do not automatically prepare an athlete for bodyweight inversion; transfer must be tested.

FIELD CHECK

If shoulder pain appears only after multiple attempts, suspect fatigue/tolerance before changing technique radically.

Chapter 34

Rib cage mechanics and breathing upside down

COACH	CLINICIAN	ATHLETE	RESEARCHER

The rib cage connects breathing, trunk stiffness and shoulder access. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Breath holding	Creates excessive bracing and fear.	Teach quiet breathing in easy holds.
Rib flare	Steals shoulder line and shifts COM.	Use exhale-to-stack work.
Rib depression excess	Can restrict shoulder access.	Find balanced trunk tone.
Breathing under load	Shows ownership of the position.	Progress when breathing remains calm.

KEY IDEA

If the athlete cannot breathe in the line, the line is not yet owned.

EVIDENCE NOTE

Spine and sagittal-alignment studies during handstand support the importance of trunk and pelvic mechanics during inversion.

CREDIBILITY & CAUTION

Do not demand maximal hollow if it blocks breathing or shoulder elevation.

FIELD CHECK

In a wall hold, require three quiet nasal breaths before the set counts.

Chapter 35

Pelvic position and lumbar control

COACH	CLINICIAN	ATHLETE	RESEARCHER

The pelvis sets the lower half of the line and influences lumbar extension. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Anterior tilt/arch	Common banana pattern.	Use rib-pelvis stacking and glute tone.
Posterior tilt excess	May create a tucked line that limits extension aesthetics.	Match the goal.
Neutral-control range	Athlete can adjust pelvis without losing balance.	Progress shape drills.
Fatigue drift	Pelvis changes late in the set.	Stop before collapse becomes practice.

KEY IDEA

The pelvis is the steering wheel of the lower-body line.

EVIDENCE NOTE

Radiographic evidence and clinical biomechanics both support analysing spinopelvic position rather than treating the trunk as a rigid stick.

CREDIBILITY & CAUTION

Pelvic correction should not be forced through pain or breath holding.

FIELD CHECK

Use a wall-facing hold and alternate gentle glute squeeze/relax. The athlete should feel pelvic change without shoulder collapse.

Chapter 36

Hip line, leg tension and long-lever balance

COACH	CLINICIAN	ATHLETE	RESEARCHER

The legs are long levers; small leg errors can move the entire system. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Soft knees	Creates variable lever length.	Cue controlled extension.
Split legs	May help early balance or perform a variation.	Use intentionally, not accidentally.
Toe point	Improves line and body awareness.	Do not prioritise over wrist/shoulder safety.
Leg separation during fatigue	Shows line-control loss.	Shorten sets or reduce complexity.

KEY IDEA

Leg tension is balance information, not decoration.

EVIDENCE NOTE

Handstand style and apparatus contexts vary, so leg-line decisions must match the task: gymnastics line, yoga control, circus balance, walking or transition.

CREDIBILITY & CAUTION

Do not over-cue legs in a beginner who has not yet learned hand pressure and exit safety.

FIELD CHECK

Compare balance with legs together, slight split and straddle. Choose the version that teaches the current target best.

Chapter 37

Neck position and visual strategy

COACH	CLINICIAN	ATHLETE	RESEARCHER

The head influences vision, vestibular input, cervical load and the whole line. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Neutral gaze	Often useful for line and calm.	Look between hands without craning.
Head lifted	May help some athletes orient but can extend spine.	Use temporarily if needed.
Tucked too much	Can disorient or round upper body.	Find visual target.
Neck pain	Warning signal.	Regress and assess.

KEY IDEA

The eyes help balance, but the neck should not pay the price for fear.

EVIDENCE NOTE

Handstand balance involves visual, vestibular and proprioceptive information; changing head position changes the sensory task.

CREDIBILITY & CAUTION

Never force neck positions in athletes with cervical symptoms, dizziness or neurological signs.

FIELD CHECK

Use a fixed gaze spot on the floor just between or slightly ahead of the hands and compare sway.

Chapter 38

Anthropometry: long arms, short arms, trunk length and hand size

COACH	CLINICIAN	ATHLETE	RESEARCHER

Body proportions change the mechanical problem. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Long arms	May ease floor clearance but change shoulder angles.	Individualise hand width and line cues.
Short arms	May require more shoulder access and compression for presses.	Progress mobility and strength together.
Long trunk	COM management may feel different.	Use line drills and pressure awareness.
Small hands	Smaller pressure platform.	Prioritise precision and surface safety.

KEY IDEA

Individualisation is not softness; it is applied mechanics.

EVIDENCE NOTE

The handstand literature includes skilled cohorts but cannot define one perfect technique for all body types; proportions and goals must guide decisions.

CREDIBILITY & CAUTION

Do not compare a tall adult beginner to a junior elite gymnast without context.

FIELD CHECK

Record height, body mass, arm span, shoulder flexion, wrist extension, hand size and training goal in the first assessment.

Chapter 39

A joint-by-joint atlas of the handstand

COACH	CLINICIAN	ATHLETE	RESEARCHER

The handstand can be read from the floor upward. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Hand	Creates base and pressure map.	Assess contact first.
Wrist	Accepts extension and moment.	Monitor symptoms and CoP shift.
Elbow	Transmits load.	Check active lockout.
Shoulder/scapula	Creates support pillar.	Check elevation/protraction.
Trunk/pelvis	Controls column.	Check breathing and line.
Legs	Complete lever.	Check fatigue drift.

KEY IDEA

From floor to feet, every joint either transmits, regulates or leaks force.

EVIDENCE NOTE

Combining direct handstand evidence with clinical kinesiology makes joint-by-joint analysis practical and credible.

CREDIBILITY & CAUTION

The atlas is not a checklist to over-cue. It is a way to find the first meaningful bottleneck.

FIELD CHECK

Use a slow-motion side view and pause at contact, stack, balance and fatigue. Score each joint region 0-2 for control.

Chapter 40

Why two athletes need different handstand styles

COACH	CLINICIAN	ATHLETE	RESEARCHER

Technique is a decision matched to a person and a goal. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Gymnastics line	Straight, controlled, aesthetic.	Prioritise shape and execution rules.
Calisthenics balance	Transfer to strength and control.	Prioritise robustness and progressions.
Yoga practice	Breath, control, position awareness.	Prioritise calm entry and sustainable holds.
CrossFit walking	Locomotor task under fatigue.	Prioritise volume management and safe exits.
Clinical return	Load tolerance first.	Prioritise exposure and symptoms.

KEY IDEA

There is no universal handstand; there are handstand solutions.

EVIDENCE NOTE

Evidence tells us mechanisms; coaching must apply those mechanisms to context.

CREDIBILITY & CAUTION

Calling every non-gymnastics line wrong is poor biomechanics. Calling every line acceptable without load reasoning is also poor biomechanics.

FIELD CHECK

Write the target in one sentence before coaching: “This athlete needs ___ for ___ by ___ date, with ___ tolerance limits.”

Chapter 41

The complete muscle atlas

COACH	CLINICIAN	ATHLETE	RESEARCHER

Muscles should be taught by mechanical role, not memorised as a list. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Primary support	Deltoids, triceps, scapular elevators/upward rotators.	Hold the body against gravity.
Steering	Finger flexors, wrist/forearm muscles.	Move pressure under the hand.
Centration	Rotator cuff and scapular stabilisers.	Keep shoulder organised.
Column control	Abdominals, spinal extensors, glutes.	Prevent line leakage.
Long lever	Hip and leg muscles.	Maintain shape and reduce noise.

KEY IDEA

The best muscle atlas answers: what is the muscle doing for the skill?

EVIDENCE NOTE

Kochanowicz et al. measured muscle activity during handstands on different apparatus, supporting a task-specific muscle interpretation.

CREDIBILITY & CAUTION

Do not reduce handstand training to shoulders and triceps; the balance system depends on the whole chain.

FIELD CHECK

For each fault, name the functional failure: support, steering, centration, column or long-lever control.

Chapter 42

Phase-by-phase muscle matrix

COACH	CLINICIAN	ATHLETE	RESEARCHER

Muscle roles change across contact, entry, stack, balance, walking and exit. Part III treats the athlete as a linked biological machine, not as an ideal stick figure. Every segment has a role: the hands sense and steer, the wrists regulate, the elbows transmit, the shoulders support, the trunk organises and the legs behave as long levers.

The professional coaching task is to identify which body region is limiting the current skill. A beautiful line that creates wrist pain is not a success; a strong shoulder that cannot coordinate with the ribs is not a pillar; a flexible spine that leaks into extension is not control.

The practical standard is joint-by-joint reasoning: observe the visible fault, identify the mechanical role of the involved region, choose the smallest useful correction, then retest balance, symptoms and repeatability.

Anatomy-to-decision table

Region / sign	Mechanical role	Coaching decision
Contact	Hands/forearms prepare pressure and load.	Use calm contact.
Entry	Shoulders and trunk accept momentum.	Control impulse.
Stack	Scapula, triceps and trunk organise the line.	Push tall and breathe.
Balance	Forearms and shoulders micro-correct.	Coach quiet pressure.
Walk	Alternating support and trunk stiffness dominate.	Cap fatigue.
Exit	Eccentric control and spatial	Practise safe bails.

	awareness.	

KEY IDEA

No muscle has one handstand job; the phase decides the job.

EVIDENCE NOTE

Phase-based analysis follows the same scientific logic used in gait, lifting and gymnastics biomechanics: define events, then interpret forces and muscle roles within those events.

CREDIBILITY & CAUTION

Programming assistance exercises without phase logic can build strength that fails to transfer.

FIELD CHECK

When selecting an accessory exercise, write which phase it supports and how you will retest transfer.

PART III INTEGRATED ASSESSMENT SHEET

Use this before prescribing progressions

Joint-by-joint screen

Region	Green flag	Yellow/red flag
Hand	Full contact, calm finger steering	Skin tearing, numbness, severe pressure avoidance
Wrist	Stable extension tolerance and no delayed symptom increase	Sharp pain, swelling, ulnar-sided pain, clicking with pain
Elbow	Active lockout without pain	Painful hyperextension, buckling, nerve symptoms
Shoulder	Tall support, no collapse, quiet neck	Painful overhead, asymmetry, uncontrolled sinking
Scapula	Upward rotation/protraction under load	Winging, rib flare compensation, rapid fatigue
Rib/pelvis	Breathable line control	Breath holding, back pain, uncontrolled arch
Leg line	Intentional lever position	Fatigue drift or uncontrolled split

REFERENCES FOR PART III

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018. https://doi.org/10.1098/rsos.161018

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140.

Kochanowicz, A., Niespodzinski, B., Mieszkowski, J., Marina, M., & Kochanowicz, K. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research, 33(6), 1609-1618.

MacDonald, M., et al. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living.

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joint moments profile during straight arm press to handstand in male gymnasts. PLOS ONE, 16(7), e0253951. https://doi.org/10.1371/journal.pone.0253951

Prassas, S. G. (1988). Biomechanical model of the press handstand in gymnastics. International Journal of Sport Biomechanics, 4(4), 326-341.

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405. https://doi.org/10.1038/s41598-020-79730-z

Eyssartier, C., et al. (2024). Spine kinematics behavior during the handstand posture. Global Spine Journal.

Hart, E. (2024). Common upper extremity gymnastics injuries and gymnastic-specific return-to-play protocols. Journal of the Pediatric Orthopaedic Society of North America.

Johnson, A., Meador, M., Bodamer, M., Langford, E., & Snarr, R. L. (2019). Exercise technique: Handstand push-up. Strength & Conditioning Journal, 41(2), 119-123. https://doi.org/10.1519/SSC.0000000000000427

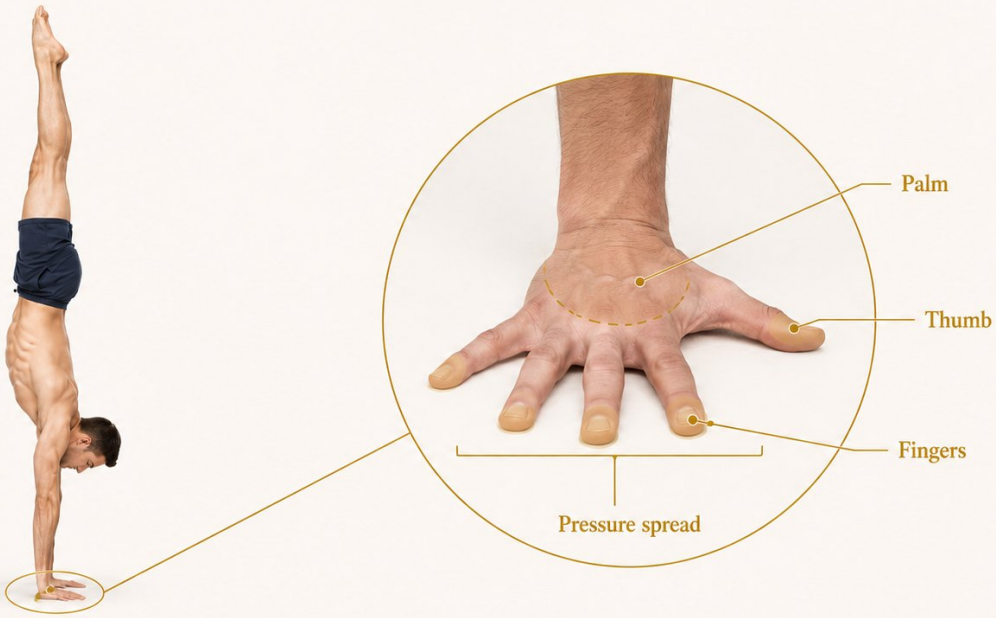
Ludewig, P. M., & Reynolds, J. F. (2009). The association of scapular kinematics and glenohumeral joint pathologies. Journal of Orthopaedic & Sports Physical Therapy, 39(2), 90-104.

Neumann, D. A. (2017). Kinesiology of the musculoskeletal system: Foundations for rehabilitation (3rd ed.). Elsevier.

Sleeper, M. D., Kenyon, L. K., Elliott, J. M., & Cheng, M. S. (2016). Measuring sport-specific physical abilities in male gymnasts: The Men's Gymnastics Functional Measurement Tool. International Journal of Sports Physical Therapy, 11(7), 1085-1100.

HS-FIG-019 | Hand Contact Platform

FIGURE 19 | Hand Contact Platform



The hand contact platform distributes pressure through the palm, fingers and thumb and provides the sensory and mechanical base for balance.

HS-FIG-020 | Wrist Extension Loading Positions

FIGURE 20 | Wrist Extension Loading Positions



Wrist loading rises from pike-based preparation to wall-supported inversion and then to full freestanding handstand work.

HS-FIG-021 | Elbow Lockout And Hyperextension

FIGURE 21 | Elbow Lockout & Hyperextension



A stable elbow lockout supports force transfer; excessive hyperextension shifts support towards passive joint structures.

HS-FIG-022 | Scapular Upward Rotation And Elevation

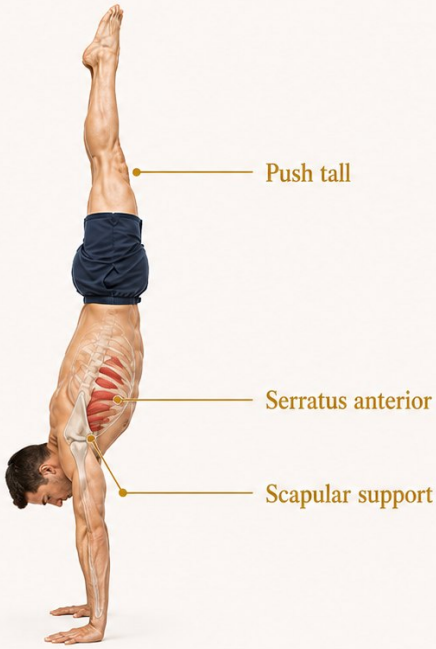
FIGURE 22 | Scapular Upward Rotation & Elevation



Successful overhead support depends on scapular upward rotation and elevation to create a strong vertical base.

HS-FIG-023 | Serratus Anterior As The Hidden Engine

FIGURE 23 | Serratus Anterior as the Hidden Engine



The serratus anterior helps drive scapular support and keeps the overhead line active rather than collapsed.

HS-FIG-024 | Rotator Cuff And Shoulder Centration

FIGURE 24 | Rotator Cuff & Shoulder Centration



The rotator cuff helps centre the shoulder joint so overhead loading can be supported with control.

HS-FIG-025 | Rib Cage And Pelvis Alignment

FIGURE 25 | Rib Cage & Pelvis Alignment



The trunk works best when the rib cage and pelvis stay organised; rib flare and pelvic tilt leak efficiency.

HS-FIG-026 | Hip Line And Leg Tension

FIGURE 26 | Hip Line & Leg Tension



Leg tension helps the hips stay organised; loose legs make the line less efficient and harder to control.

HS-FIG-027 | Head And Neck Position In Handstand

FIGURE 27 | Head & Neck Position in Handstand



A quiet head and neck position supports balance; excessive cervical extension adds unnecessary strain and can disturb the line.

HS-FIG-028 | Anthropometry Comparison

FIGURE 28 | Anthropometry Comparison



Anthropometry changes the shapes and angles used to reach the same balance task; different bodies need different solutions.

PART IV

Balance Control and Skill Acquisition

Correction, timing and motor learning.



FINGER STRATEGY
Grip, pressure & feel

SHOULDER STRATEGY
Elevation, protraction & stability

VISUAL CONTROL
Focus, gaze & reference

MICRO-CORRECTION
Adjust, re-center, repeat

Chapter 43

Balance as active correction, not stillness

BEGINNER | COACH | RESEARCHER

A good handstand looks quiet, but it is not passive. The body is always drifting because the centre of mass is high above a narrow hand base. The athlete succeeds by detecting drift early and correcting it while the error is still small.

The mechanical target is not a frozen body. The target is a body that can tolerate small oscillations without losing the stack. In MMSx language, the athlete is not holding a pose; the athlete is regulating a vertical load column through the hands.

Beginners usually wait until the body is falling before they respond. Skilled athletes correct before the fall becomes visible. That is the coaching difference between a save and a control strategy.

Table IV.1. Balance-control language

Term	Useful meaning	Coaching decision
Drift	Centre of mass moves away from stable control	Name the direction before cueing
Correction	Pressure or shape response that reduces drift	Train earlier and smaller corrections
Save	Large late correction after loss of line	Regress the drill or reduce entry speed
Quiet hold	Low-amplitude oscillation with calm breathing	Progress only if repeatable

KEY IDEA

Stillness is the visual result of early correction, not the absence of movement.

EVIDENCE NOTE

Handstand-specific research describes balance through centre-of-pressure and centre-of-mass interactions, with wrist strategy dominant in skilled inverted balance.

CREDIBILITY & CAUTION

Do not praise a long hold if it is achieved through breath holding, painful wrist pressure or uncontrolled lumbar extension.

Figure IV-1. Balance strategy priority during handstand learning.

FIGURE 29 | Finger Strategy



Finger pressure acts like a fine steering system, allowing small corrections without changing the whole body dramatically.

Chapter 44

Visual, vestibular and proprioceptive inputs

COACH | CLINICIAN | RESEARCHER

Inversion changes the sensory problem. Vision is no longer organised around upright locomotion, vestibular input is challenged by head position, and proprioception must interpret load through the hands rather than the feet.

The eyes should support the task without forcing neck extension. The athlete can use a consistent gaze point between the hands or slightly forward, but the head position must not break the shoulder stack or increase cervical stress.

The proprioceptive system learns through repeated loaded exposure. This is why short, clean, frequent attempts often transfer better than a few desperate long attempts.

Table IV.2. Sensory inputs and coaching use

Input	Handstand role	Practical drill
Vision	Stabilises orientation and target	Quiet gaze in wall line
Vestibular	Detects inverted head/body motion	Slow kick-up and controlled exit
Proprioception	Detects wrist, shoulder and trunk position	Toe pulls, heel pulls, pressure shifts
Tactile pressure	Reports hand load map	Finger pressure practice

KEY IDEA

The handstand is a sensory re-mapping task before it becomes a performance task.

EVIDENCE NOTE

The 2025 systematic review reports that visual conditions and head positions affect handstand balance, supporting careful cueing of gaze and cervical position.

CREDIBILITY & CAUTION

A gaze cue is not harmless if it creates neck compression, rib flare or shoulder angle loss.

Chapter 45

Finger-pressure strategy

BEGINNER | COACH | ATHLETE

The fingers are not decoration. They are the steering surface. When the body begins to pass too far over the fingertips, increased finger pressure can shift the centre of pressure and slow the fall.

Beginners often keep the fingers flat or stiff. That removes a major balance tool. Coaches should teach the hand as a living base: palm rooted, knuckles heavy, fingers active and responsive.

Finger-pressure drills should be introduced before the athlete expects a long freestanding hold. The learner should feel the floor, not merely push through it.

Table IV.3. Finger-pressure errors

Error	Likely effect	First correction
Flat passive fingers	Late response to overbalance	Rocking plank pressure drills
Clawing hard	Fatigue and panic	Relax palm then pulse pressure
Unequal hand pressure	Side drift or twist	Mark hand placement and retest
Thumb unloaded	Poor mediolateral correction	Tripod hand cue

KEY IDEA

The hand steers balance by changing pressure, especially through the fingers.

EVIDENCE NOTE

Handstand control studies identify wrist strategy as the dominant inverted balance response; finger pressure is the practical field expression of that strategy.

CREDIBILITY & CAUTION

Finger pressure should not become cramping or clawing. Excessive tension increases fatigue and reduces sensitivity.

Chapter 46

Wrist strategy versus shoulder strategy

COACH RESEARCHER

The wrist strategy is efficient because small changes at the hand can influence the entire inverted body. However, if drift becomes too large, the athlete may recruit the shoulder, hip or elbow as part of a mixed strategy.

The coach should not remove shoulder correction entirely. Shoulder movement becomes necessary in dynamic skills, handstand walking and large balance disturbances. The question is sequence: small wrist correction first, larger body correction only when required.

A handstand that constantly waves through the shoulders is usually not advanced expression; it is often late correction.

Table IV.4. Strategy selection

Situation	Preferred strategy	Progression choice
Small forward drift	Finger/wrist pressure	Toe-pull repeats
Large forward drift	Wrist plus shoulder	Reduce kick-up speed
Side drift	Hand pressure asymmetry correction	Line drill with markers
Walking	Shoulder shift plus hand step	Weight-shift ladder

KEY IDEA

Wrist correction is the first line of control; shoulder correction is a second line when the error grows.

EVIDENCE NOTE

Blenkinsop and colleagues reported wrist strategy as the dominant handstand strategy, while the systematic review describes mixed strategies when wrist control is insufficient.

CREDIBILITY & CAUTION

Do not cue “only use the fingers” in walking or advanced dynamic work; the task may require shoulder and trunk strategies.

Figure IV-2. Skill acquisition loop for handstand balance.

FIGURE 35 | Micro-Correction Sequence in Freestanding Balance



Skilled handstand balance is maintained through small, timely corrections rather than large dramatic saves.

Chapter 47

Expertise: how advanced athletes correct less but better

ATHLETE | COACH | RESEARCHER

Expertise is not simply the ability to survive longer. It is the ability to reduce unnecessary correction, regulate drift with lower noise and recover the line with less visible disturbance.

A beginner often creates large error at entry, waits too long, then produces a large correction. An advanced athlete enters closer to the target line, detects drift earlier and corrects with smaller pressure shifts.

Training should therefore measure quality, not just duration. A thirty-second hold with five major saves is a different skill from a fifteen-second quiet hold.

Table IV.5. Beginner versus expert correction

Feature	Beginner	Expert direction
Entry	Variable kick speed	Repeatable entry window
Drift detection	Late and emotional	Early and specific
Correction size	Large saves	Small pressure changes
Breathing	Often held	Quiet and repeatable
Exit	Reactive fall	Planned bail

KEY IDEA

Expert balance is economical: less visible correction, earlier timing and cleaner repetition.

EVIDENCE NOTE

Coordination research comparing expertise levels shows that higher-level handstand performers organise the task differently from less-skilled performers.

CREDIBILITY & CAUTION

Do not confuse rigidity with expertise. A rigid athlete may look straight but fail transfer to press, walk or fatigue contexts.

Chapter 48

Practice design: blocked, variable and transfer work

COACH ATHLETE

Early practice should simplify the task enough for success. Later practice must vary the task enough for transfer. A learner may begin with blocked wall line work, then progress to heel pulls, kick-ups, angle changes and walking entries.

Variable practice is not random chaos. It is structured exposure to the errors the athlete must learn to solve. The coach changes one variable at a time: wall distance, entry speed, hand width, hold target, exit direction or fatigue state.

The goal is a handstand that survives real conditions, not only the perfect corner of the gym.

Table IV.6. Practice structure

Stage	Practice type	Example
Acquisition	Blocked	5 x 20 s chest-to-wall line
Correction	Serial	Wall line, heel pull, toe pull
Transfer	Variable	Kick-up from marked and unmarked starts
Performance	Contextual	Short holds after strength fatigue

KEY IDEA

Practice should move from clean repetition to controlled variability.

EVIDENCE NOTE

Motor-learning reviews support the value of practice structure, feedback design and transfer-focused variability when learning complex skills.

CREDIBILITY & CAUTION

Do not introduce variability before the athlete has a safe exit and repeatable basic loading capacity.

Chapter 49

Fear, arousal and balance noise

BEGINNER | COACH | CLINICIAN

Fear changes mechanics. The athlete may bend the elbows, throw the head, over-kick, hold the breath or bail before the body reaches the line. These are not character flaws; they are protective strategies.

A good coach reduces threat by teaching exit skill, using progressive exposure and avoiding humiliation. The nervous system balances better when it trusts the exit.

The MMSx rule is clear: confidence is trained by controllable exposure, not forced bravery.

Table IV.7. Fear signs and coaching actions

Sign	Mechanical expression	Coaching action
Over-kick	Momentum overwhelms line	Wall stop drill
Elbow bend	Protective collapse	Elevated pike loading
Head throw	Visual panic	Fixed gaze with spotter
Immediate bail	Threat response	Cartwheel bail practice

KEY IDEA

A calmer athlete has more available correction bandwidth.

EVIDENCE NOTE

Balance performance is influenced by sensory, motor and psychological state; load-management consensus statements also recognise psychological load as part of athlete readiness.

CREDIBILITY & CAUTION

Do not force inversion in an athlete who cannot exit safely. Panic creates poor mechanics and unnecessary risk.

Chapter 50

Fatigue as a balance disruptor

COACH | ATHLETE | CLINICIAN

Fatigue reduces precision before it removes strength. Fingers react later, shoulders sag, ribs flare and the athlete begins to save rather than control.

The best handstand sessions stop technical work before the nervous system becomes noisy. Strength or conditioning can follow, but balance-quality practice must be protected.

The coach should track not only hold duration but also number of clean entries, number of major saves, exit quality and next-day wrist or shoulder response.

Table IV.8. Fatigue stop rules

Signal	Meaning	Decision
Shoulder sag	Support capacity dropping	End balance work
Finger cramp	Pressure sensitivity declining	Rest or regress
Repeated unsafe bails	Threat/fatigue overload	Stop free attempts
Pain rising	Tissue tolerance exceeded	End loaded inversion

KEY IDEA

Fatigue changes the control system; volume must respect the quality of correction.

EVIDENCE NOTE

The IOC load consensus and resistance-training literature support monitoring load response rather than progressing volume blindly.

CREDIBILITY & CAUTION

Do not chase personal records in handstand balance at the end of high-fatigue sessions unless the purpose is explicitly fatigue tolerance and safety is controlled.

PART IV reference apparatus

EVIDENCE HIERARCHY

Direct handstand studies are prioritised first; gymnastics, motor-control, strength-training, and clinical load-management literature are used only when they explain mechanisms not yet isolated in handstand-specific trials.

Table R.1. Evidence-to-practice translation audit

Source type	Use in this part	Limit
Direct handstand biomechanics	Balance, CoP/CoM, wrist strategy, press-to-handstand, EMG	Often small samples and expert-biased cohorts
Gymnastics injury / RTP	Wrist, elbow, shoulder, spine loading and return-to-sport logic	Sport-specific, not always transferable to recreational adults
Motor learning	Cueing, feedback, variable practice, skill retention	Requires contextual coaching judgement
Strength and load-management consensus	Progression, tissue adaptation and monitoring	Does not replace individual assessment

Core references used in this part

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018.

Chua, L. K., Jimenez-Diaz, J., Lewthwaite, R., Kim, T., & Wulf, G. (2021). Superiority of external attentional focus for motor performance and learning: Systematic reviews and meta-analyses. Psychological Bulletin, 147(6), 618-645.

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140.

Johnson, A., Meador, M., Bodamer, M., Langford, E., & Snarr, R. L. (2019). Exercise technique: Handstand push-up. Strength & Conditioning Journal, 41(2), 119-123.

Kochanowicz, A., Niespodziński, B., Mieszkowski, J., Marina, M., & Kochanowicz, K. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research.

Lauersen, J. B., Bertelsen, D. M., & Andersen, L. B. (2014). The effectiveness of exercise interventions to prevent sports injuries: A systematic review and meta-analysis of randomised controlled trials. British Journal of Sports Medicine, 48(11), 871-877.

MacDonald, M., Baker, J., & colleagues. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living.

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joints moments profile during straight arm press to handstand in male gymnasts. PLOS ONE, 16(7), e0253951.

Soligard, T., Schwellnus, M., Alonso, J. M., Bahr, R., Clarsen, B., et al. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of injury. British Journal of Sports Medicine, 50(17), 1030-1041.

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405.

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. International Review of Sport and Exercise Psychology, 6(1), 77-104.

Hart, E. (2024). Common upper extremity gymnastics injuries and gymnastic-specific return-to-play protocols. Journal of the Pediatric Orthopaedic Society of North America.

Lloyd, R. S., Faigenbaum, A. D., Stone, M. H., et al. (2014). Position statement on youth resistance training: The 2014 International Consensus. British Journal of Sports Medicine, 48(7), 498-505.

Transition to the next part

Part V now converts control into capacity: the wrist, elbow, shoulder, trunk, hip and nervous system must be prepared to tolerate the load they are learning to control.

HS-FIG-029 | Finger Strategy

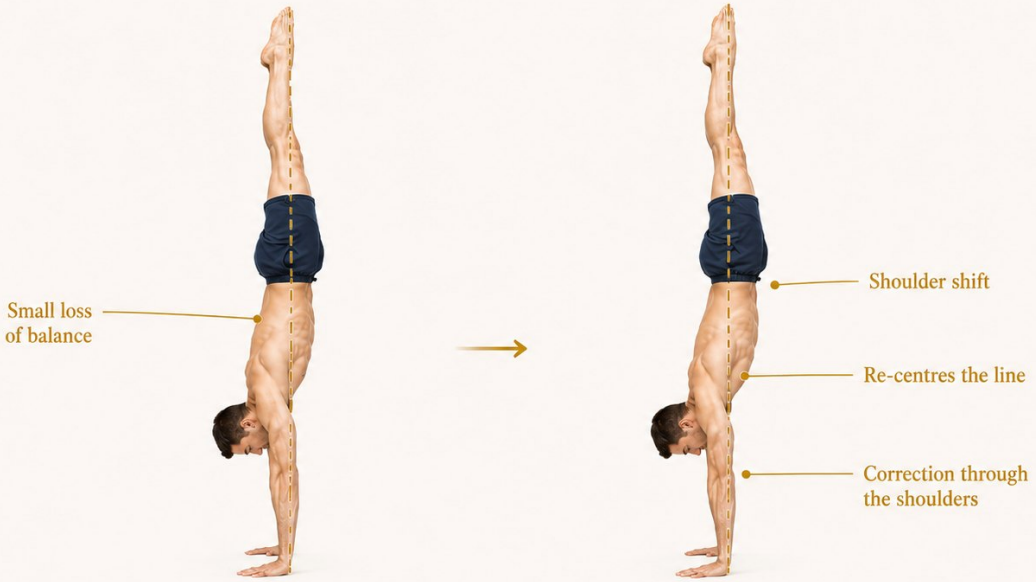
FIGURE 29 | Finger Strategy



Finger pressure acts like a fine steering system, allowing small corrections without changing the whole body dramatically.

HS-FIG-030 | Shoulder Strategy

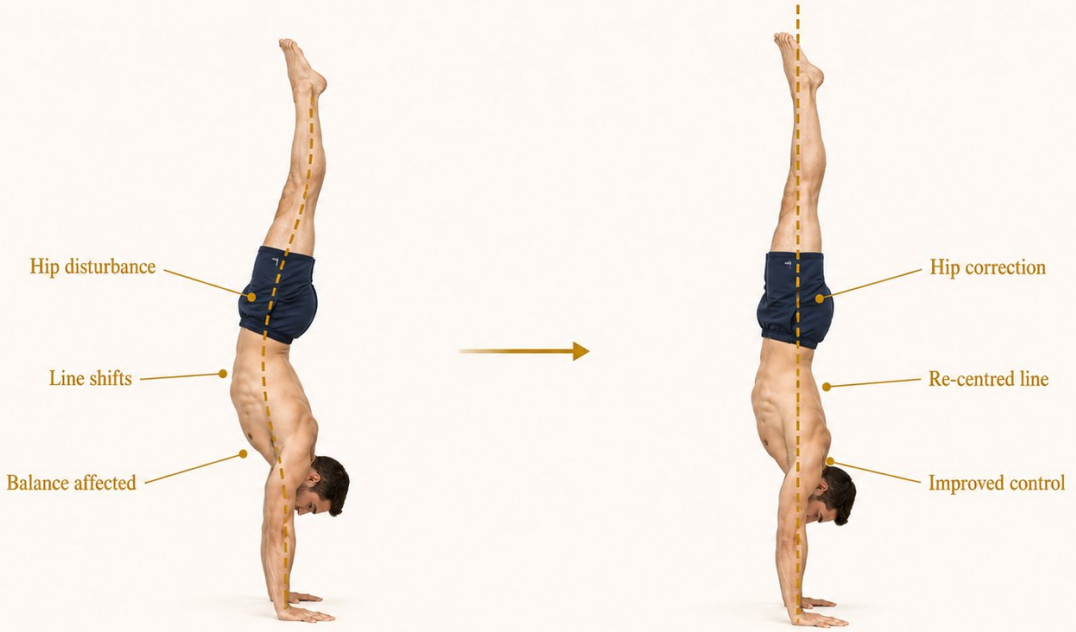
FIGURE 30 | Shoulder Strategy



Small adjustments through the shoulders can re-centre the body over the hands and restore balance.

HS-FIG-031 | Hip Strategy And Line Disturbance

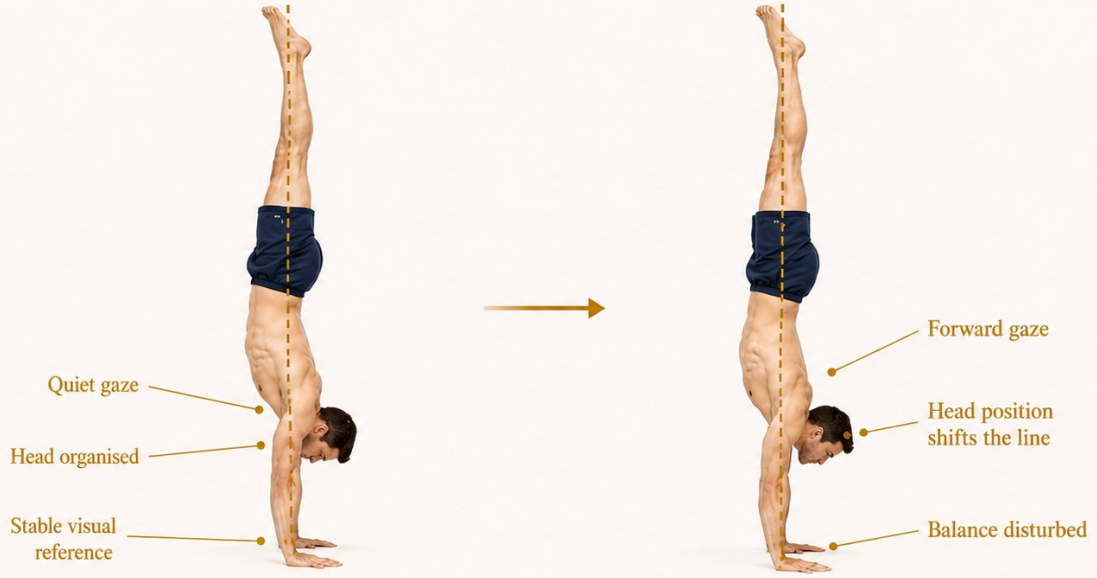
FIGURE 31 | Hip Strategy & Line Disturbance



Small changes at the hips can disturb the handstand line; organised hip correction helps restore a more efficient balance position.

HS-FIG-032 | Visual Strategy And Head Position

FIGURE 32 | Visual Strategy & Head Position



Where the athlete looks influences balance; a quiet head and visual reference help keep the handstand more organised.

HS-FIG-033 | Heel Pulls At The Wall

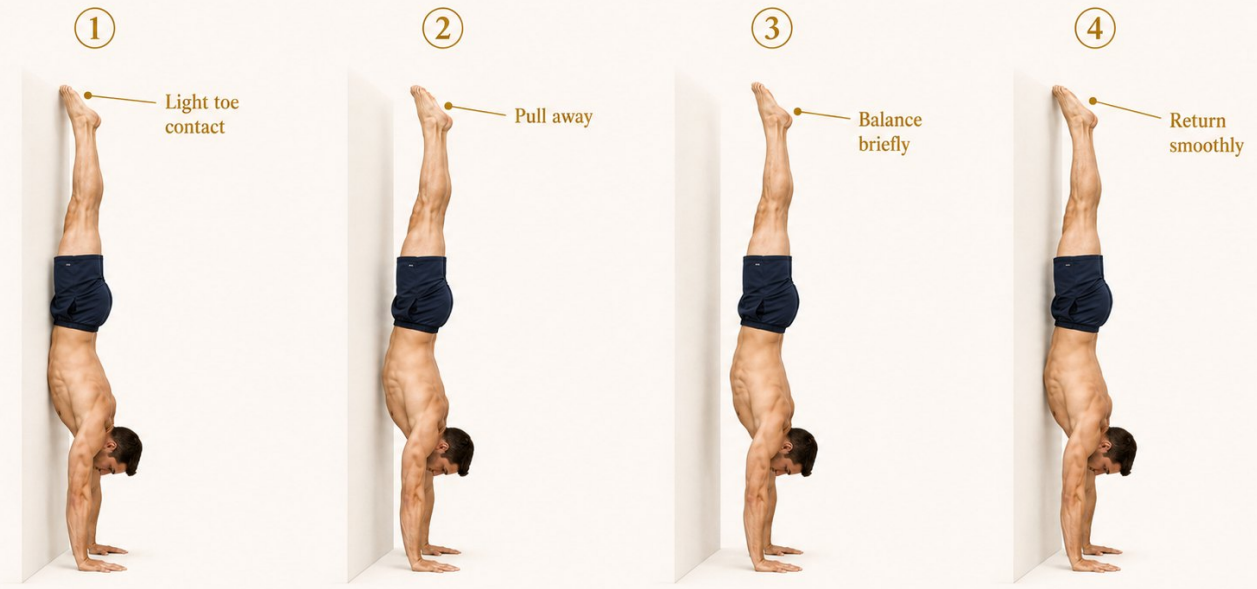
FIGURE 33 | Heel Pulls at the Wall



Heel pulls teach the athlete to leave wall support briefly while keeping the line tall and organised.

HS-FIG-034 | Toe Pulls At The Wall

FIGURE 34 | Toe Pulls at the Wall



Toe pulls help the athlete move away from wall dependence and organise a short freestanding balance moment.

HS-FIG-035 | Micro Correction Sequence In Freestanding Balance

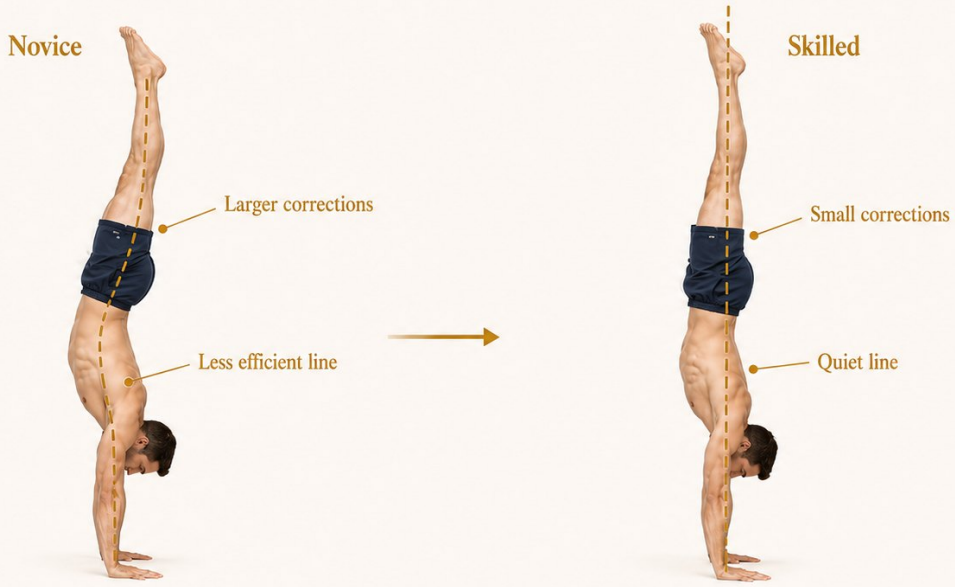
FIGURE 35 | Micro-Correction Sequence in Freestanding Balance



Skilled handstand balance is maintained through small, timely corrections rather than large dramatic saves.

HS-FIG-036 | Novice Vs Skilled Balance Behaviour

FIGURE 36 | Novice vs Skilled Balance Behaviour



Novices often use larger and less efficient corrections; skilled handstanders keep the line quieter and make smaller balance adjustments.

HS-FIG-037 | Over Kick Under Kick Correct Kick

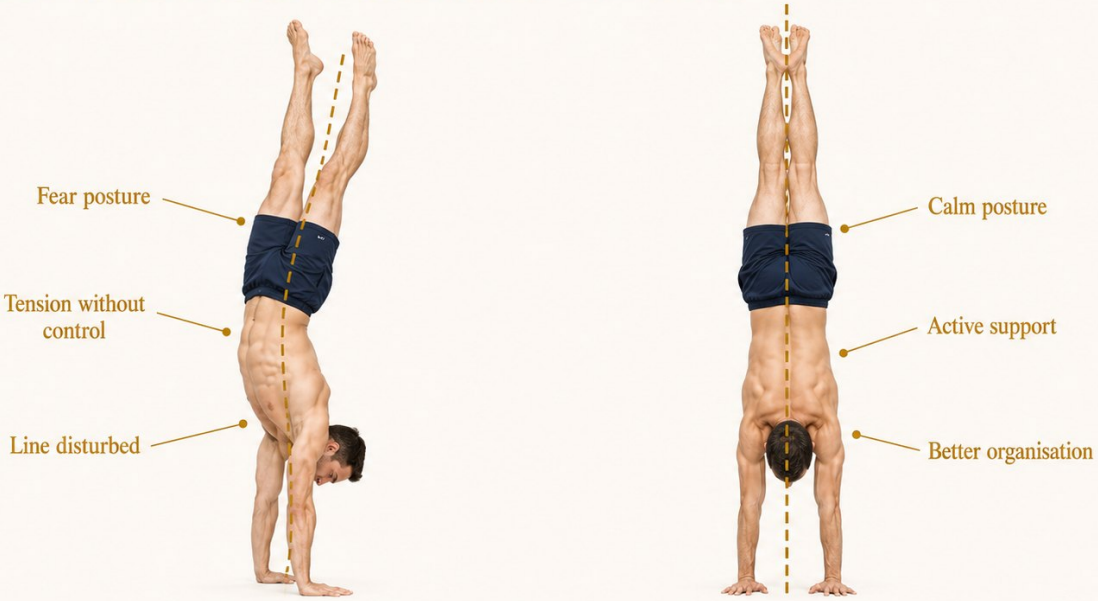
FIGURE 37 | Over-Kick, Under-Kick, Correct Kick



The kick-up must deliver enough momentum to reach balance, but not so much that the athlete overshoots the line.

HS-FIG-038 | Fear Posture Vs Calm Posture In Inversion

FIGURE 38 | Fear Posture vs Calm Posture in Inversion



Emotional state changes movement behaviour; calm organisation usually produces a cleaner and more controllable inverted line.

PART V

MOBILITY, STRENGTH AND CAPACITY FOUNDATIONS

Prepare the wrists, shoulders, trunk and line.



WRISTS
Prepare & Protect

SHOULDERS
Build Strength & Control

TRUNK
Stability & Alignment

CAPACITY
Build Endurance

MMSx Authority Institute for
Movement Mechanics & Biomechanics Research

Chapter 61

Wrist extension capacity

BEGINNER | CLINICIAN | COACH

The handstand asks the wrist to bear bodyweight in extension. That is not a minor mobility detail; it is the first mechanical gate into safe inversion.

Passive wrist extension is only the beginning. The athlete must also tolerate compressive load, finger pressure, repeated exposure and small centre-of-pressure shifts without symptom escalation.

A professional progression starts with unloaded range, then quadruped loading, then inclined loading, then wall-supported loading, and only later high-volume freestanding work.

Table V.1. Wrist capacity ladder

Level	Task	Pass criterion
1	Pain-free unloaded extension	Comfortable range both sides
2	Quadruped rock	No sharp pain or guarding
3	Incline handstand lean	Even palm and finger pressure
4	Wall hold	No symptom increase next day
5	Freestanding pressure shifts	Control without wrist threat

KEY IDEA

A wrist that can move is not automatically a wrist that can load.

EVIDENCE NOTE

Gymnastics injury literature consistently identifies the wrist as a major load-bearing region; handstand balance literature places wrist strategy at the centre of control.

CREDIBILITY & CAUTION

Persistent ulnar-sided wrist pain, swelling, loss of grip or pain in daily activities requires professional assessment before further inversion loading.

Figure V-1. Capacity exposure curve across an eight-week on-ramp.

FIGURE 40 | Wall Plank & Pike Load



Wall plank and pike-loading drills build the foundational shoulder and trunk support needed before full inversion.

Chapter 62

Elbow lockout and load line

COACH ATHLETE

The elbow should transmit force without becoming the main balance hinge. Some athletes naturally hyperextend; others struggle to lock out. Both patterns need coaching rather than moral judgement.

The goal is a stable long-arm support that stacks the elbow between wrist and shoulder while allowing the shoulder and hand to regulate balance.

If the elbow bends under load, the athlete may lack confidence, shoulder support, triceps endurance or entry control. The correction depends on the cause.

Table V.2. Elbow patterns

Pattern	Likely cause	Decision
Soft elbow	Fear or low support capacity	Regress to pike and wall line
Locked but collapsed shoulder	Shoulder not elevating	Serratus and push-tall drills
Painful lockout	Tissue irritation	Reduce load and refer if persistent
Excess hyperextension	Passive lock reliance	Teach active support without dumping

KEY IDEA

The elbow is a force transmitter, not the main steering wheel.

EVIDENCE NOTE

Handstand systematic evidence describes wrist strategy first, with elbow strategy appearing as part of mixed control when other strategies are insufficient.

CREDIBILITY & CAUTION

Do not force a painful elbow into locked range. Pain, instability or history of injury changes the decision.

Chapter 63

Shoulder flexion and overhead tolerance

COACH | CLINICIAN | ATHLETE

A handstand requires the arms overhead under bodyweight. Limited shoulder flexion often appears as rib flare, lumbar extension, bent elbows or the hands placed too far from the line.

The mobility goal is not a passive wall test alone. The athlete must own the range under load with scapular elevation, upward rotation and trunk control.

Shoulder preparation should combine mobility, active end-range control, serratus work and progressive inversion exposure.

Table V.3. Shoulder readiness checkpoints

Checkpoint	Green	Yellow	Red
Wall shoulder flexion	Arms overhead without rib flare	Mild compensation	Pain or major arch
Wall handstand	Push tall retained	Fatigue sag	Unable to support
Heel pull	Shoulder line stable	Late correction	Collapse or pain
Walking prep	Weight shift controlled	Asymmetry	Sharp pain or instability

KEY IDEA

Shoulder range must become loaded overhead support.

EVIDENCE NOTE

Straight-arm press-to-handstand analysis and handstand EMG/apparatus research support the importance of shoulder mechanics and muscular control in inverted support.

CREDIBILITY & CAUTION

Pinching, apprehension or repeated shoulder pain during overhead loading should not be stretched through aggressively.

Figure V-2. Capacity domains before advanced inversion.

FIGURE 48 | Shoulder Flexion Mobility Test Position



Shoulder-flexion testing helps identify whether overhead range is sufficient for efficient handstand stacking.

Chapter 64

Scapular elevation strength

COACH ATHLETE

“Push tall” is not a decorative cue. Scapular elevation and upward rotation help create the vertical support platform that keeps the body from sinking into the shoulders.

Many beginners confuse shrugging with support. Effective elevation is coordinated with rib control, elbow lockout and pressure through the hand.

The coach should train scapular elevation in pike positions, wall handstand holds, scapular handstand shrugs and controlled shoulder taps.

Table V.4. Scapular progression

Drill	Purpose	Stop rule
Pike scap push	Learn elevation without full load	Neck pain or elbow bend
Wall scap shrug	Specific inverted elevation	Loss of line
Shoulder tap prep	Single-arm support transition	Hip twist or pain
Freestanding correction	Integrate with balance	Repeated uncontrolled saves

KEY IDEA

The shoulder girdle must lift the body away from the floor while preserving the line.

EVIDENCE NOTE

EMG and apparatus studies show that shoulder-girdle musculature contributes substantially to handstand support and stabilisation.

CREDIBILITY & CAUTION

Do not add handstand push-ups to an athlete who cannot maintain tall shoulder support in a static hold.

Chapter 65

Trunk hollow-body capacity

BEGINNER **COACH**

The trunk is the line-control column. Without rib-pelvis control, the athlete often solves shoulder limitation by arching the spine and shifting the centre of mass away from the base.

Hollow-body training should not be treated as a generic abdominal exercise. It is a line rehearsal for inversion: ribs controlled, pelvis organised, legs long and breathing quiet.

The handstand line must eventually be maintained under load, fatigue and correction, not only on the floor.

Table V.5. Trunk-line faults

Fault	Mechanical effect	Correction
Rib flare	CoM shifts and lumbar load rises	Wall hollow breathing
Anterior pelvic tilt	Banana line	Glute-rib connection drills
Leg separation	Long-lever asymmetry	Toe point and squeeze cue
Breath hold	Rigidity and fatigue	Timed nasal breathing holds

KEY IDEA

The trunk decides whether shoulder range becomes a line or an arch.

EVIDENCE NOTE

Handstand biomechanics and coaching literature consistently treat body alignment as central to balance quality and scoring aesthetics.

CREDIBILITY & CAUTION

A perfectly flat hollow shape is not the goal for every body; the goal is a controllable line that matches the skill and tolerates load.

Chapter 66

Strength endurance for wall holds

COACH | ATHLETE

Wall holds are useful when they build clean load tolerance. They become less useful when they reward collapse, breath holding or passive hanging into the shoulder structures.

The quality standard should be stricter than the clock. A twenty-second clean hold is better training than a sixty-second compensatory hold.

Endurance progresses by adding total quality exposure: more sets, slightly longer holds, shorter rest or more demanding wall angle. Only one variable should change at a time.

Table V.6. Wall-hold dosing rules

Stage	Set target	Quality rule
Early	5-10 s repeats	Exit before shake
Base	15-25 s holds	Line and breath retained
Capacity	30-45 s holds	No next-day symptom rise
Transfer	Short holds + heel pulls	Correction quality retained

KEY IDEA

Wall endurance must be measured by quality time, not survival time.

EVIDENCE NOTE

Load-management consensus statements support progressive exposure and monitoring of response rather than sudden changes in training load.

CREDIBILITY & CAUTION

Do not increase handstand volume when next-day wrist or shoulder symptoms are rising.

Chapter 67

Press-to-handstand prerequisite strength

ADVANCED **COACH**

The straight-arm press to handstand is a different task from a kick-up. It demands shoulder compression, trunk control, hip compression, scapular support and the ability to move the centre of mass over the hands without momentum.

Press training should begin with compression strength, elevated pike shifts, straddle leans and eccentric patterning before demanding a clean floor press.

A press built on uncontrolled elbow bend or lumbar dumping is not a press foundation. It is compensation.

Table V.7. Press prerequisites

Capacity	Minimum sign	Prep drill
Shoulder lean tolerance	Controlled pike lean	Box pike lean
Compression	Knees-to-chest lift control	Seated compression lifts
Scapular support	Tall arms during lean	Pike scap shrugs
Balance transfer	Controlled toe float	Straddle toe-lift attempts

KEY IDEA

The press converts balance into slow centre-of-mass management.

EVIDENCE NOTE

Mizutori and colleagues examined kinematics and joint moments during straight-arm press to handstand in highly skilled male gymnasts, supporting the need for specific joint-moment preparation.

CREDIBILITY & CAUTION

Do not add press volume to athletes with wrist pain or poor shoulder support. The loading time under compression is high.

PART V reference apparatus

EVIDENCE HIERARCHY

Direct handstand studies are prioritised first; gymnastics, motor-control, strength-training, and clinical load-management literature are used only when they explain mechanisms not yet isolated in handstand-specific trials.

Table R.1. Evidence-to-practice translation audit

Source type	Use in this part	Limit
Direct handstand biomechanics	Balance, CoP/CoM, wrist strategy, press-to-handstand, EMG	Often small samples and expert-biased cohorts
Gymnastics injury / RTP	Wrist, elbow, shoulder, spine loading and return-to-sport logic	Sport-specific, not always transferable to recreational adults
Motor learning	Cueing, feedback, variable practice, skill retention	Requires contextual coaching judgement
Strength and load-management consensus	Progression, tissue adaptation and monitoring	Does not replace individual assessment

Core references used in this part

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018.

Chua, L. K., Jimenez-Diaz, J., Lewthwaite, R., Kim, T., & Wulf, G. (2021). Superiority of external attentional focus for motor performance and learning: Systematic reviews and meta-analyses. Psychological Bulletin, 147(6), 618-645.

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140.

Johnson, A., Meador, M., Bodamer, M., Langford, E., & Snarr, R. L. (2019). Exercise technique: Handstand push-up. Strength & Conditioning Journal, 41(2), 119-123.

Kochanowicz, A., Niespodziński, B., Mieszkowski, J., Marina, M., & Kochanowicz, K. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research.

Lauersen, J. B., Bertelsen, D. M., & Andersen, L. B. (2014). The effectiveness of exercise interventions to prevent sports injuries: A systematic review and meta-analysis of randomised controlled trials. British Journal of Sports Medicine, 48(11), 871-877.

MacDonald, M., Baker, J., & colleagues. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living.

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joints moments profile during straight arm press to handstand in male gymnasts. PLOS ONE, 16(7), e0253951.

Soligard, T., Schwellnus, M., Alonso, J. M., Bahr, R., Clarsen, B., et al. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of injury. British Journal of Sports Medicine, 50(17), 1030-1041.

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405.

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. International Review of Sport and Exercise Psychology, 6(1), 77-104.

Hart, E. (2024). Common upper extremity gymnastics injuries and gymnastic-specific return-to-play protocols. Journal of the Pediatric Orthopaedic Society of North America.

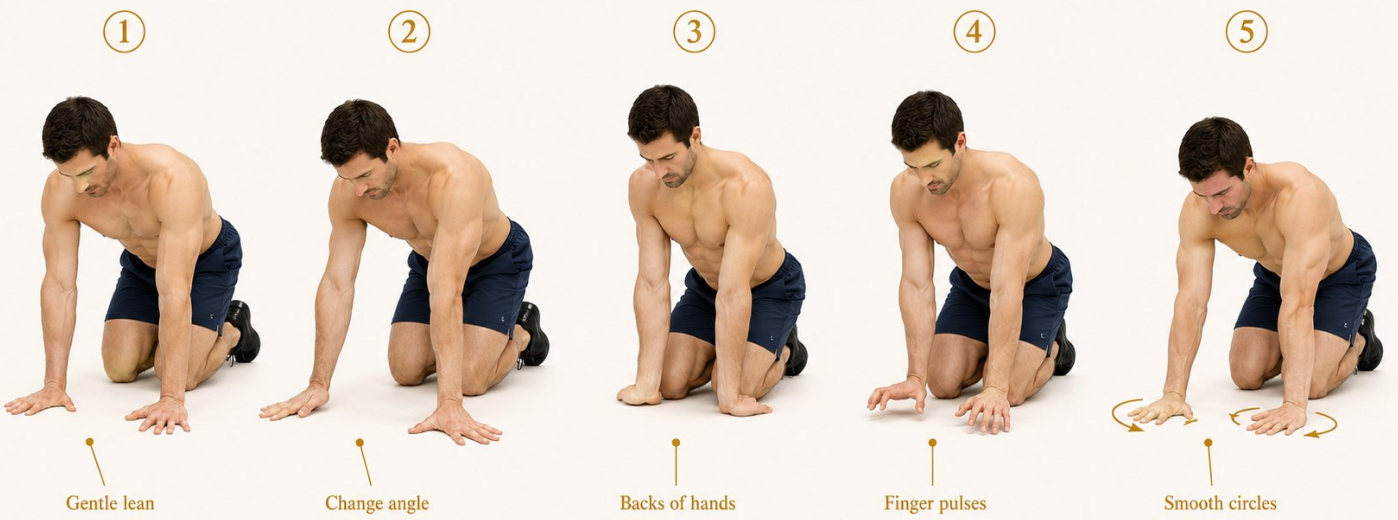
Lloyd, R. S., Faigenbaum, A. D., Stone, M. H., et al. (2014). Position statement on youth resistance training: The 2014 International Consensus. British Journal of Sports Medicine, 48(7), 498-505.

Transition to the next part

Part VI now turns the prepared human system into a phase-by-phase atlas. Each moment of the skill has its own event definition, failure signature and correction decision.

HS-FIG-039 | Wrist Warm Up Series

FIGURE 39 | Wrist Warm-Up Series



A graded wrist warm-up helps prepare the hands and wrists for the extension demands of inverted support.

HS-FIG-040 | Wall Plank And Pike Load

FIGURE 40 | Wall Plank & Pike Load



Wall plank and pike-loading drills build the foundational shoulder and trunk support needed before full inversion.

HS-FIG-041 | Box Handstand Progression

FIGURE 41 | Box Handstand Progression



Box handstand progressions build shoulder support, stacking awareness and confidence before full inversion.

HS-FIG-042 | Wall Walk Progression

FIGURE 42 | Wall Walk Progression



Wall walks teach inversion entry, shoulder loading and line control through a graded climb to vertical support.

HS-FIG-043 | Chest To Wall Handstand Hold

FIGURE 43 | Chest-to-Wall Handstand Hold



The chest-to-wall hold teaches vertical stacking, active shoulder support and efficient line organisation.

HS-FIG-044 | Shoulder Tap And Weight Shift Drills

FIGURE 44 | Shoulder Tap & Weight-Shift Drills



Weight-shift and shoulder-tap drills develop unilateral support control, balance tolerance and handstand confidence.

HS-FIG-045 | Serratus Wall Slide Overhead Shrug Drill

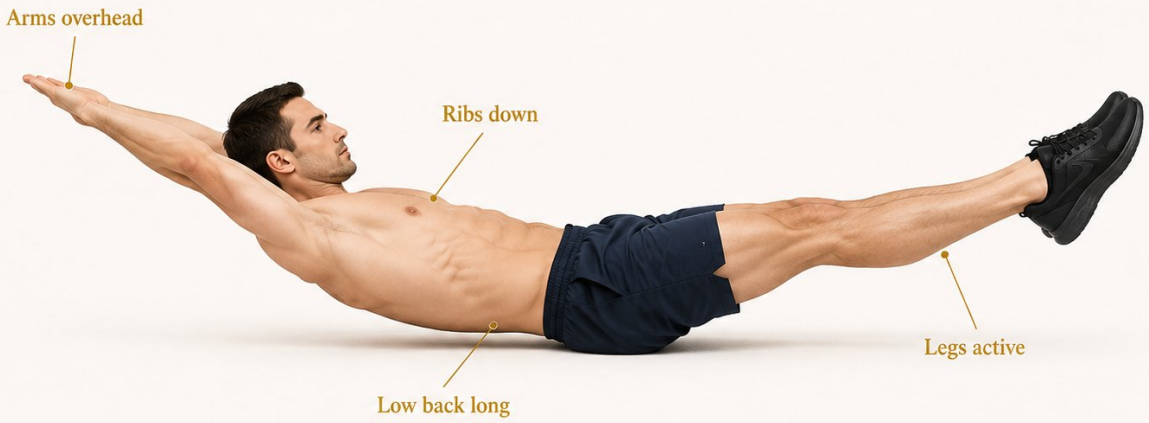
FIGURE 45 | Serratus Wall Slide / Overhead Shrug Drill



Serratus-focused wall slides and overhead shrugs help prepare the shoulder girdle for active inverted support.

HS-FIG-046 | Hollow Body Hold

FIGURE 46 | Hollow-Body Hold



The hollow-body hold builds trunk stiffness and line control that transfer directly to organised handstand positions.

HS-FIG-047 | Pike Compression Lift Seated Compression

FIGURE 47 | Pike Compression Lift / Seated Compression



Pike compression drills strengthen active hip flexion and trunk control, both essential for press-to-handstand preparation.

HS-FIG-048 | Shoulder Flexion Mobility Test Position

FIGURE 48 | Shoulder Flexion Mobility Test Position



Shoulder-flexion testing helps identify whether overhead range is sufficient for efficient handstand stacking.

PART VI

THE COMPLETE PHASE ATLAS

From entry to exit.



Approach · Kick-up · Catch · Line · Exit

LINE CONTROL
Balance & Alignment

SHOULDER ENGINE
Protraction & Stability

CORE INTEGRITY
Stiffness & Transfer

POWER IN MOTION
Step, Shift, Sustain

MMSx Authority Institute for
Movement Mechanics & Biomechanics Research

Chapter 79

Phase model and event definitions

COACH RESEARCHER

A handstand cannot be coached accurately if every problem is labelled “bad form.” The phase model separates the skill into events: hand placement, entry, stack, line, balance, hold, transfer and exit.

Each event has a different mechanical question. Hand placement asks whether the base is organised. Entry asks whether momentum is controlled. Balance asks whether pressure correction is early enough. Exit asks whether failure is safe.

The phase model is the basis for professional diagnosis. It prevents a coach from correcting the shoulder when the real error occurred during kick-up speed.

Table VI.1. Eight-phase model

Phase	Main question	Primary metric
1 Hand placement	Is the base repeatable?	Hand width and pressure
2 Entry	Is momentum controlled?	Kick speed and line arrival
3 Stack	Are joints organised?	Wrist-elbow-shoulder relation
4 Line	Is the trunk column controlled?	Rib-pelvis-leg alignment
5 Balance	Is drift corrected early?	Save count
6 Hold	Can quality persist?	Clean seconds
7 Transfer	Can task change?	Tap/walk/press control
8 Exit	Can failure be safe?	Bail quality

KEY IDEA

Faults must be traced to the phase where they begin, not where they become obvious.

EVIDENCE NOTE

Handstand and press-to-handstand studies use identifiable movement events and mechanical variables, supporting event-based analysis.

CREDIBILITY & CAUTION

Do not overload beginners with phase language during practice. Use it for coaching decisions, then translate into simple cues.

Figure VI-1. Eight-phase handstand model.

FIGURE 49 | Freestanding Handstand Phase Model



A freestanding handstand unfolds as a sequence of entry, capture, organisation, correction, stable hold and safe exit.

Chapter 80

Phase 1: floor approach and hand placement

BEGINNER COACH

The handstand begins before the feet leave the floor. Hand width, finger spread, palm pressure and shoulder distance from the hands determine the first balance problem.

A repeatable hand placement reduces noise. Beginners benefit from floor marks, hand-width references and a simple tripod-hand cue: heel of palm, knuckle base and fingers active.

Too narrow a base may increase side-to-side instability. Too wide a base may limit shoulder elevation and make walking inefficient.

Table VI.2. Hand placement decisions

Observation	Likely effect	Decision
Hands too wide	Shoulder support reduced	Bring toward shoulder-width
Hands too narrow	Side wobble	Mark slightly wider base
Fingers passive	Late balance correction	Finger-pressure drill
Uneven pressure	Twist or side fall	Reset hand angle

KEY IDEA

A predictable base creates a predictable balance problem.

EVIDENCE NOTE

Centre-of-pressure research makes the hand contact area central to inverted balance control.

CREDIBILITY & CAUTION

Do not force one hand width for all athletes. Shoulder structure, hand size, task and comfort matter.

Chapter 81

Phase 2: entry and momentum control

BEGINNER **COACH**

The kick-up creates the initial energy of the handstand. Too little energy never reaches the line; too much energy forces a save or a bail.

The entry should be trained as a repeatable dose of momentum. The athlete learns to kick to the line, not through the line.

Wall-stop drills and controlled kick-up to split position are useful because they teach the athlete where the line is before demanding long freestanding control.

Table VI.3. Entry faults

Fault	Mechanical problem	Correction
Under-kick	CoM remains behind hands	Kick-up to wall marker
Over-kick	CoM passes fingers too fast	Wall stop and toe-pull
Twisted entry	Asymmetric leg swing	Line on floor + slow split kick
Head throw	Neck breaks stack	Quiet gaze cue

KEY IDEA

The best balance correction is the error the entry never creates.

EVIDENCE NOTE

Event-based skill research and motor-learning principles support repeated, constrained entry practice before open freestanding attempts.

CREDIBILITY & CAUTION

Do not let a learner repeat violent kick-ups. Repetition of poor entry is not practice; it is error rehearsal.

Figure VI-2. Common phase-linked fault burden.

HS-FIG-058 | Common Phase Faults Montage



Recognise the fault early, choose one correction and retest the same phase.

Chapter 82

Phase 3: first stack and shoulder organisation

COACH **ATHLETE**

When the feet rise, the athlete must quickly organise wrist, elbow and shoulder. A late shoulder push creates a sagging line and makes balance correction expensive.

The first stack is not a fixed geometric perfection. It is the first usable arrangement that allows the athlete to carry load and correct pressure.

Coaches should watch for the shoulder collapsing toward the ears passively, elbows softening or ribs opening as the athlete searches for the line.

Table VI.4. First-stack audit

Region	Green sign	Red sign
Wrist	Loaded evenly	Pain/guarding
Elbow	Long active support	Bending under fear
Shoulder	Tall and stable	Sagging or pinching
Ribs	Controlled	Immediate flare

KEY IDEA

First stack determines whether the athlete balances from organisation or from rescue.

EVIDENCE NOTE

Handstand EMG and kinematic studies show substantial shoulder-girdle involvement during inverted support.

CREDIBILITY & CAUTION

Do not cue stronger push if the athlete lacks wrist tolerance or is using pain avoidance to change the stack.

Chapter 83

Phase 4: line organisation

COACH ATHLETE

Line organisation is the moment when the athlete becomes one controllable column. The legs, pelvis, ribs, shoulders and hands must stop behaving as separate pieces.

A banana shape may reflect shoulder limitation, trunk weakness, fear, poor cueing or an intentional style. The coach should decide by context rather than appearance alone.

The operational question is: can this line be held, corrected, breathed in and progressed without symptoms?

Table VI.5. Line decisions

Line issue	Possible cause	Test
Banana shape	Shoulder flexion or rib control	Wall line plus shoulder flexion screen
Piked hips	Fear or hamstring/compression issue	Wall hold and hollow body
Split legs	Entry strategy or asymmetry	Freestanding split-to-together drill
Neck extension	Visual strategy	Gaze retest

KEY IDEA

A useful line is a controllable line.

EVIDENCE NOTE

The systematic review highlights joint angles and body configuration as recurring handstand analysis variables.

CREDIBILITY & CAUTION

Do not sacrifice shoulder comfort or breathing for an aesthetic line that the athlete cannot own.

Chapter 84

Phase 5: balance correction

COACH RESEARCHER

Balance correction begins when the athlete senses drift. The first response should usually come from the hand and wrist, with the shoulder and trunk joining when the drift is larger.

The correction phase is the key bridge between wall work and freestanding handstand. Wall drills must expose controlled drift rather than hiding it completely.

Heel pulls, toe pulls and fingertip pressure pulses teach the athlete to create and resolve small balance errors safely.

Table VI.6. Correction drills

Drill	Error exposed	Coaching target
Heel pull	Falling away from wall	Find centre without panic
Toe pull	Overbalance toward fingers	Use pressure early
Shoulder tap	Weight-shift error	Keep trunk quiet
Line walk	Dynamic drift	Step before collapse

KEY IDEA

Correction skill is trained by controlled error exposure.

EVIDENCE NOTE

Blenkinsop et al. and Wyatt et al. provide direct evidence that handstand balance depends on CoP/CoM interaction and wrist-dominant control strategies.

CREDIBILITY & CAUTION

Do not treat every fall as lack of strength. Many falls are timing and pressure errors.

Chapter 85

Phase 6: hold endurance and fatigue drift

ATHLETE | **COACH**

Once the athlete can balance, the next problem is maintaining quality under time. Fatigue first appears as drift, shoulder sag, finger overwork or breathing change.

Endurance should be trained as high-quality accumulated seconds. The coach should count clean seconds rather than total inverted seconds.

A useful endurance session might use many short holds with strict stop rules rather than one maximal hold that ends in collapse.

Table VI.7. Hold quality score

Score	Description	Decision
3	Quiet line, small corrections, safe exit	Progress
2	Minor drift, controlled save	Repeat
1	Large saves, breath held, shaky exit	Regress or stop
0	Pain or unsafe fall	Stop and reassess

KEY IDEA

Endurance is the ability to keep the same decision quality under rising fatigue.

EVIDENCE NOTE

Load-management and motor-control principles support monitoring quality and response under fatigue.

CREDIBILITY & CAUTION

Maximal handstand endurance attempts are not appropriate for every session and should not be used during pain return.

Chapter 86

Phase 7: transfer and task change

COACH	ATHLETE

Transfer is the phase where a handstand stops being only a hold and becomes another task: a step, a tap, a turn, a press, a push-up descent, a return to the wall, or a safe transition into walking. It is the missing bridge between static balance and usable inverted skill.

Many athletes can hold a clean line but fail when the task changes. The reason is mechanical: transfer briefly narrows support, shifts centre of pressure, changes shoulder demand and asks the trunk to preserve line while one part of the system moves.

The professional coaching standard is to separate hold quality from transfer quality. A ten-second handstand does not automatically authorise shoulder taps, walking, press work or handstand push-up volume. Each transfer must be tested as its own decision.

Table VI.8. Phase 7 transfer audit

Transfer demand	Pass standard	If not passed
Weight shift	Body moves over one hand without shoulder collapse.	Return to wall shifts or reduce the range.
Shoulder tap	Tap is quiet; pelvis and ribs do not swing.	Use toe support, wall taps or smaller lifts.
Walk initiation	Forward lean is deliberate; first step is small.	Rebuild lean, tap and single-step drills.
Task change under fatigue	Line remains recognisable after repeated attempts.	End the set before collapse becomes the teacher.

KEY IDEA

Transfer is not a bonus after balance; it is the phase where balance proves it can survive task change.

EVIDENCE NOTE

Handstand balance research supports event-based analysis: pressure control, shoulder strategy and centre-of-mass behaviour change when the task becomes dynamic.

CREDIBILITY & CAUTION

Do not progress from stillness to walking or tapping until the athlete can shift load without shoulder sag, rib flare, panic or unsafe exit behaviour.

Figure VI-8. Phase 7 transfer turns a handstand hold into a usable movement skill.

Chapter 87

Phase 8: exit and fall management

BEGINNER | CLINICIAN | COACH

The exit is part of the skill, not an emergency after the skill fails. A safe bail gives the nervous system permission to practise balance. Exit quality is therefore a technical standard, not an afterthought.

Most learners should master a cartwheel-style bail or controlled step-down before repeated freestanding attempts. The exact exit depends on the context, surface, body type and coaching environment.

An athlete who cannot fail safely cannot yet train freely. For rehabilitation, youth athletes, group classes and online coaching, exit competence should be verified before speed, walking or fatigue-based challenges.

Table VI.9. Exit progression

Exit layer	Pass standard	Programming decision
Wall step-down	Learner can return feet without panic.	Use before repeated wall exposure.
Cartwheel bail	Hands stay planted; body turns safely to feet.	Required before frequent free attempts.
Soft failed kick-up	Athlete under-kicks or redirects without collapse.	Builds confidence and repetition volume.
Fatigue exit	Athlete exits before shoulder or wrist collapse.	Defines end-of-set quality standard.

KEY IDEA

A handstand is not complete until the athlete can leave it safely and repeatedly.

EVIDENCE NOTE

Motor-learning and gymnastics safety logic support early exit practice because fear and unsafe failure reduce repetition quality.

CREDIBILITY & CAUTION

Do not use repeated free attempts when every failed attempt ends in collapse, wrist dumping or uncontrolled spinal extension.

Figure VI-9. Exit skill converts failure into safe, repeatable learning.

PART VI reference apparatus

EVIDENCE HIERARCHY

Direct handstand studies are prioritised first; gymnastics, motor-control, strength-training, and clinical load-management literature are used only when they explain mechanisms not yet isolated in handstand-specific trials.

Table R.1. Evidence-to-practice translation audit

Source type	Use in this part	Limit
Direct handstand biomechanics	Balance, CoP/CoM, wrist strategy, press-to-handstand, EMG	Often small samples and expert-biased cohorts
Gymnastics injury / RTP	Wrist, elbow, shoulder, spine loading and return-to-sport logic	Sport-specific, not always transferable to recreational adults
Motor learning	Cueing, feedback, variable practice, skill retention	Requires contextual coaching judgement
Strength and load-management consensus	Progression, tissue adaptation and monitoring	Does not replace individual assessment

Core references used in this part

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018.

Chua, L. K., Jimenez-Diaz, J., Lewthwaite, R., Kim, T., & Wulf, G. (2021). Superiority of external attentional focus for motor performance and learning: Systematic reviews and meta-analyses. Psychological Bulletin, 147(6), 618-645.

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140.

Johnson, A., Meador, M., Bodamer, M., Langford, E., & Snarr, R. L. (2019). Exercise technique: Handstand push-up. Strength & Conditioning Journal, 41(2), 119-123.

Kochanowicz, A., Niespodziński, B., Mieszkowski, J., Marina, M., & Kochanowicz, K. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research.

Lauersen, J. B., Bertelsen, D. M., & Andersen, L. B. (2014). The effectiveness of exercise interventions to prevent sports injuries: A systematic review and meta-analysis of randomised controlled trials. British Journal of Sports Medicine, 48(11), 871-877.

MacDonald, M., Baker, J., & colleagues. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living.

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joints moments profile during straight arm press to handstand in male gymnasts. PLOS ONE, 16(7), e0253951.

Soligard, T., Schwellnus, M., Alonso, J. M., Bahr, R., Clarsen, B., et al. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of injury. British Journal of Sports Medicine, 50(17), 1030-1041.

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405.

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. International Review of Sport and Exercise Psychology, 6(1), 77-104.

Hart, E. (2024). Common upper extremity gymnastics injuries and gymnastic-specific return-to-play protocols. Journal of the Pediatric Orthopaedic Society of North America.

Lloyd, R. S., Faigenbaum, A. D., Stone, M. H., et al. (2014). Position statement on youth resistance training: The 2014 International Consensus. British Journal of Sports Medicine, 48(7), 498-505.

Transition to the next part

Part VII now turns this phase atlas into a complete beginner-to-advanced progression ladder.

HS-FIG-049 | Freestanding Handstand Phase Model

FIGURE 49 | Freestanding Handstand Phase Model



A freestanding handstand unfolds as a sequence of entry, capture, organisation, correction, stable hold and safe exit.

HS-FIG-050 | Chest To Wall Handstand Phase Model

FIGURE 50 | Chest-to-Wall Handstand Phase Model



The chest-to-wall handstand can be organised as a clear sequence of entry, line establishment, supported hold and controlled exit.

HS-FIG-051 | Back To Wall Handstand Phase Model



HS-FIG-052 | Tuck Handstand

HS-FIG-052 | Tuck Handstand



The tuck shape shortens the lever and helps the athlete organise balance.

HS-FIG-053 | Straddle Handstand



HS-FIG-054 | Split Handstand



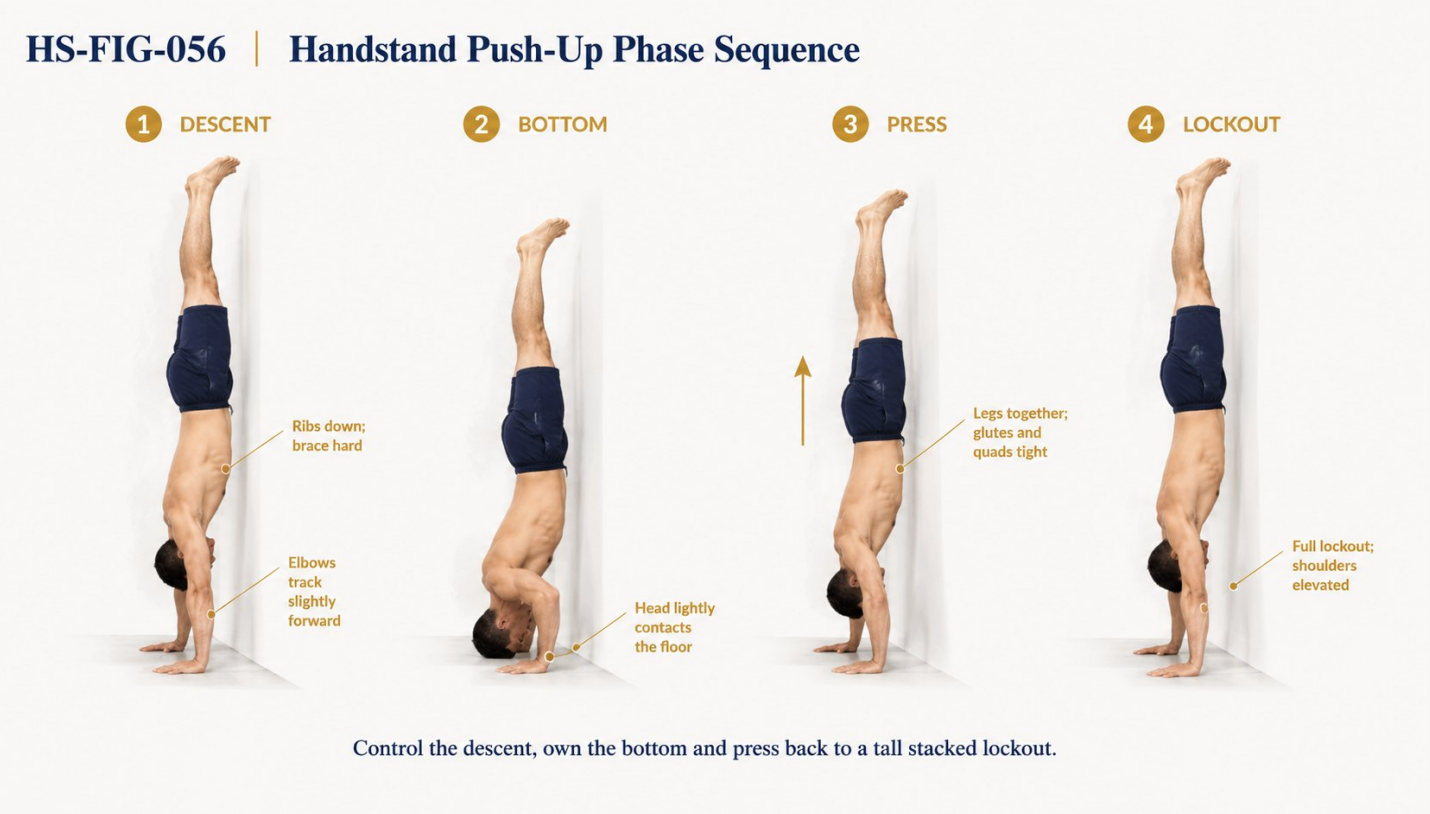
The split handstand changes lever length and demands precise line control.

HS-FIG-055 | Press To Handstand Phase Sequence



Shift the shoulders, raise the hips and press the legs with control into line.

HS-FIG-056 | Handstand Push Up Phase Sequence



Control the descent, own the bottom and press back to a tall stacked lockout.

HS-FIG-057 | Handstand Walk Phase Model



Walking is repeated controlled forward balance with clean weight transfer and recovery.

HS-FIG-058 | Common Phase Faults Montage



Recognise the fault early, choose one correction and retest the same phase.

PART VII

BEGINNER-TO-ADVANCED PROGRESSION LADDER

From wall support to freestanding control.



LOAD | ALIGN | CONTROL | PROGRESS

Chapter 101

How to use the progression ladder

BEGINNER **COACH**

The ladder is not a race. It is a decision sequence. Each rung should solve a mechanical problem and prepare the next rung with less risk than guessing.

An athlete may move quickly through some rungs and stay longer at others. Wrist capacity, shoulder mobility, fear, body size, training age and prior injury all change the route.

The MMSx progression rule is: never move up because the calendar says so; move up because the movement has become repeatable, quiet and symptom-tolerant.

Table VII.1. Rung pass criteria

Criterion	Required standard	Reason
Pain response	No sharp or rising symptoms	Protects tissue capacity
Exit	Calm and repeatable	Protects learning and safety
Line	Stable enough to correct	Prepares transfer
Dose recovery	No next-day escalation	Guides frequency

KEY IDEA

Progression is earned by repeatable control, not by ambition.

EVIDENCE NOTE

Load-management consensus and motor-learning evidence support staged exposure and response monitoring.

CREDIBILITY & CAUTION

A drill that looks easy on video may be excessive for a specific athlete.

Figure VII-1. Progression ladder from first load to freestanding control.

HS-FIG-059
Absolute Beginner Inversion Ladder

1 QUADRUPED



2 PIKE



3 WALL LOAD



Chapter 102

Absolute beginner wrist and base preparation

BEGINNER | CLINICIAN

The first handstand session should often contain no full handstand. It should teach the hands how to load, the wrists how to tolerate extension and the athlete how to feel pressure without fear.

Quadruped rocks, palm lifts, finger pressure pulses and incline plank leans give the athlete the language of the base before inversion.

This stage is especially important for adult beginners, desk-bound clients and athletes with low prior weight-bearing exposure through the hands.

Table VII.2. Base-prep session

Drill	Dose	Purpose
Wrist circles	1-2 min	Warm range
Quadruped rocks	2 x 10	Loaded extension
Finger pressure pulses	3 x 8	Pressure awareness
Incline plank lean	3 x 10 s	Entry-level support

KEY IDEA

The handstand starts with hand confidence before upside-down confidence.

EVIDENCE NOTE

Handstand balance research makes hand pressure central, while gymnastics injury literature supports respect for wrist exposure.

CREDIBILITY & CAUTION

Do not dismiss wrist discomfort as weakness. It is a load-response signal.

Chapter 103

Box and pike loading progression

BEGINNER **COACH**

The box handstand reduces the balance threat while introducing shoulder loading. It is the bridge between floor preparation and wall inversion.

The athlete should learn to push tall, keep the ribs controlled and shift small amounts of weight into the hands without collapsing.

A high box reduces load; a lower box and more vertical torso increase specificity. The coach chooses the angle that gives challenge without fear or pain.

Table VII.3. Pike progression

Level	Body position	Progress when
1	Hands on bench, feet floor	No wrist pain
2	Feet on box, hips high	Shoulders push tall
3	Walk hands closer	Line improves without panic
4	One-leg pike shifts	Weight transfer controlled

KEY IDEA

Pike loading teaches the body to support inversion before full inversion is demanded.

EVIDENCE NOTE

Progressive resistance-training principles support graded load exposure and task-specific progression.

CREDIBILITY & CAUTION

Avoid letting the athlete dump into passive shoulder elevation or hold the breath in pike holds.

Chapter 104

Wall walk and chest-to-wall line

BEGINNER **COACH**

The wall walk builds confidence, shoulder endurance and spatial awareness. Chest-to-wall work usually teaches a cleaner line than back-to-wall work because it discourages excessive arching.

The athlete should walk in only as far as they can still breathe, push tall and exit under control. Closer to the wall is not better if the exit becomes unsafe.

Wall work should be paired with line education: ribs controlled, pelvis organised, legs active and fingers sensing pressure.

Table VII.4. Wall-walk decision rules

Observation	Decision
Clean walk-up, calm breathing	Progress hold time slowly
Can hold but cannot walk down	Train exit, not longer holds
Ribs flare near wall	Stop farther from wall and rebuild line
Wrist pain appears	Reduce angle/volume and reassess

KEY IDEA

The wall should teach line and tolerance without hiding panic.

EVIDENCE NOTE

Coaching practice and balance-control principles support wall-supported exposure as a foundation, provided transfer drills are later included.

CREDIBILITY & CAUTION

Never trap an anxious learner too close to the wall without a rehearsed exit.

Chapter 105

Heel pulls and toe pulls

INTERMEDIATE **COACH**

Heel pulls and toe pulls are the bridge from wall support to freestanding balance. They create small, controlled balance errors and teach the athlete to recover without leaving the wall completely.

The drill should be quiet. If the athlete crashes back to the wall or repeatedly falls out, the correction window is too large.

The coaching target is early finger pressure, shoulder stability and calm re-contact with the wall if needed.

Table VII.5. Pull drill progressions

Drill	Direction trained	Common error
Heel pull	Away from wall to centre	Over-pull and fall
Toe pull	From wall pressure to balance	Passive fingers
Split heel pull	Entry/line control	Hip twist
Timed free float	Short freestanding exposure	Breath hold

KEY IDEA

Controlled wall separation teaches the correction that wall holds hide.

EVIDENCE NOTE

CoP/CoM balance research supports training pressure correction, not only static support.

CREDIBILITY & CAUTION

Do not rush heel pulls in an athlete who lacks safe exit or wrist tolerance.

Figure VII-2. Twelve-week progression emphasis.


HS-FIG-068 | Weekly Progression Example
1 WEEK 1
2 WEEK 2
3 WEEK 3
4 WEEK 4
chest to wall
controlled kick-up
Progress weekly only when the previous step is calm, clean and repeatable.

Chapter 106

Freestanding kick-up practice

INTERMEDIATE ATHLETE

Freestanding kick-up practice should be measured by clean attempts, not total attempts. The athlete is learning to dose entry momentum and arrive near the balance window.

A professional session uses a small number of high-quality attempts, feedback, rest and retest. It does not turn into random kicking until exhaustion.

The athlete should be able to name the miss: short, long, twisted, soft arms, head movement or poor pressure.

Table VII.6. Attempt audit

Miss type	Likely cause	Next attempt focus
Short	Too little kick or fear	Aim split higher
Long	Too much kick	Finger pressure early
Twist	Asymmetric hands/legs	Line markers
Soft arms	Support/fear	Regress to wall stack

KEY IDEA

Freestanding practice becomes skill when the athlete can classify the miss.

EVIDENCE NOTE

Motor-learning literature supports feedback and error recognition as part of durable skill acquisition.

CREDIBILITY & CAUTION

Stop the set when misses become unsafe or indistinguishable. Random failure is not high-level practice.

Chapter 107

Five-second hold to thirty-second hold

ATHLETE **COACH**

The first five-second hold is a milestone but not a licence for unlimited volume. The athlete must make the hold repeatable before chasing thirty seconds.

Duration grows through clean attempts, not desperation. Use clusters of short holds, quality stop rules and enough rest for correction to stay precise.

Thirty seconds should mean thirty seconds of handstand, not thirty seconds of survival.

Table VII.7. Hold-duration ladder

Target	Practice method	Pass criterion
3-5 s	Many clean singles	Safe exit each time
8-12 s	Short clusters	One or fewer major saves
15-20 s	Accumulated quality time	Breathing retained
30 s	Low-frequency longer holds	No symptom escalation

KEY IDEA

Extend duration only when correction quality survives the added time.

EVIDENCE NOTE

Training load and skill acquisition principles support progressive duration increases guided by quality and recovery.

CREDIBILITY & CAUTION

Do not let the athlete add time by increasing lumbar arch or shoulder collapse.

PART VII reference apparatus

EVIDENCE HIERARCHY

Direct handstand studies are prioritised first; gymnastics, motor-control, strength-training, and clinical load-management literature are used only when they explain mechanisms not yet isolated in handstand-specific trials.

Table R.1. Evidence-to-practice translation audit

Source type	Use in this part	Limit
Direct handstand biomechanics	Balance, CoP/CoM, wrist strategy, press-to-handstand, EMG	Often small samples and expert-biased cohorts
Gymnastics injury / RTP	Wrist, elbow, shoulder, spine loading and return-to-sport logic	Sport-specific, not always transferable to recreational adults
Motor learning	Cueing, feedback, variable practice, skill retention	Requires contextual coaching judgement
Strength and load-management consensus	Progression, tissue adaptation and monitoring	Does not replace individual assessment

Core references used in this part

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018.

Chua, L. K., Jimenez-Diaz, J., Lewthwaite, R., Kim, T., & Wulf, G. (2021). Superiority of external attentional focus for motor performance and learning: Systematic reviews and meta-analyses. Psychological Bulletin, 147(6), 618-645.

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140.

Johnson, A., Meador, M., Bodamer, M., Langford, E., & Snarr, R. L. (2019). Exercise technique: Handstand push-up. Strength & Conditioning Journal, 41(2), 119-123.

Kochanowicz, A., Niespodziński, B., Mieszkowski, J., Marina, M., & Kochanowicz, K. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research.

Lauersen, J. B., Bertelsen, D. M., & Andersen, L. B. (2014). The effectiveness of exercise interventions to prevent sports injuries: A systematic review and meta-analysis of randomised controlled trials. British Journal of Sports Medicine, 48(11), 871-877.

MacDonald, M., Baker, J., & colleagues. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living.

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joints moments profile during straight arm press to handstand in male gymnasts. PLOS ONE, 16(7), e0253951.

Soligard, T., Schwellnus, M., Alonso, J. M., Bahr, R., Clarsen, B., et al. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of injury. British Journal of Sports Medicine, 50(17), 1030-1041.

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405.

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. International Review of Sport and Exercise Psychology, 6(1), 77-104.

Hart, E. (2024). Common upper extremity gymnastics injuries and gymnastic-specific return-to-play protocols. Journal of the Pediatric Orthopaedic Society of North America.

Lloyd, R. S., Faigenbaum, A. D., Stone, M. H., et al. (2014). Position statement on youth resistance training: The 2014 International Consensus. British Journal of Sports Medicine, 48(7), 498-505.

Transition to the next part

Part VIII now takes balance into locomotion: the handstand walk changes the task from holding the line to repeatedly catching a controlled fall.

HS-FIG-059 | Absolute Beginner Inversion Ladder



Build the hands, shoulders and line gradually before chasing full inversion.

HS-FIG-060 | Wall Progression Ladder



Progress from supported pike loading to a calm chest-to-wall handstand.

HS-FIG-061 | From Wall Hold To Freestanding



HS-FIG-062 | Five Second To Thirty Second Hold Ladder



HS-FIG-063 | Tuck To Straddle To Full Line Progression



HS-FIG-064 | Safe Exit Progression



HS-FIG-065 | Press To Handstand Introduction Drills



HS-FIG-066 | Handstand Push Up Introduction Drills



HS-FIG-067 | Endurance Progression Figure



HS-FIG-068 | Weekly Progression Example With Athlete Snapshots



PART VIII

HANDSTAND WALK

Step, shift and sustain.



LEAN
Stack and align.

SHIFT
Transfer with control.

STEP
Place with purpose.

RECOVER
Stabilise and repeat.

Chapter 123

Why walking is not just holding plus steps

ATHLETE **COACH**

A static handstand asks the athlete to keep the centre of mass over the hands. A handstand walk asks the athlete to let the centre of mass move forward and repeatedly move the base under it.

This is why some athletes can hold but cannot walk, and others can walk but cannot hold still. The tasks overlap but are not identical.

Walking requires single-arm support, forward lean control, alternating pressure, shoulder endurance, trunk stiffness, rhythm and safe termination.

Table VIII.1. Static versus walking demands

Demand	Static handstand	Handstand walk
COM task	Hold over base	Move ahead of base
Support	Two-hand continuous	Alternating single-arm
Correction	Pressure and line	Step timing plus pressure
Fatigue	Static endurance	Dynamic shoulder volume
Exit	Bail from stillness	Bail from forward motion

KEY IDEA

Handstand walking is controlled falling with repeated base replacement.

EVIDENCE NOTE

Dynamic balance principles and handstand control research support treating walking as a different balance-control problem from static holding.

CREDIBILITY & CAUTION

Do not use handstand walks as beginner conditioning. The fatigue and fall risk are higher than static wall work.

Figure VIII-1. Handstand walk locomotion cycle.

HS-FIG-057
Handstand Walk Phase Model



Chapter 124

Controlled forward lean

COACH **ATHLETE**

The walk begins with forward lean. Too little lean and the athlete cannot step. Too much lean and the athlete must run on the hands or crash.

Forward lean should be small, deliberate and recoverable. The athlete should feel that the step solves the lean rather than panicking after the fall begins.

Lean drills include wall shoulder shifts, box shoulder taps, controlled free lean to step and short lane walks.

Table VIII.2. Forward lean decisions

Observation	Likely meaning	Correction
No step occurs	Lean too small or fear	Assisted lean drill
Hands chase rapidly	Lean too large	Shorter lane and stop target
Shoulder collapses	Support capacity limit	Return to shoulder taps
Twist on step	Unequal hand pressure	Line walk with markers

KEY IDEA

The first walking skill is not stepping; it is dosing forward imbalance.

EVIDENCE NOTE

CoP/CoM interaction models explain why base replacement must match centre-of-mass motion.

CREDIBILITY & CAUTION

Avoid long-distance walking practice when the athlete cannot stop within one or two steps.

Figure VIII-2. Handstand walk demand profile.

HS-FIG-073 | Pressure Transfer During Walking



Support hand accepts load while stepping hand moves forward.

Chapter 125

Hand placement during walking

COACH | ATHLETE

During walking, each hand becomes a temporary base. Step length, hand angle and width influence the ability to recover the line.

Shorter steps usually offer more control early. Long steps may be faster but increase single-arm time and correction demand.

The hand should land where it can support the shoulder and steer pressure, not simply where it happens to reach.

Table VIII.3. Step-placement rules

Rule	Reason	Drill
Step small first	Reduces overbalance	Tape-line micro steps
Land under shoulder path	Supports stack	Shoulder shift drills
Keep fingers active	Steering after contact	Finger pulse holds
Train stopping	Prevents crash patterns	Walk-stop-walk drills

KEY IDEA

Every hand step is a new base-of-support decision.

EVIDENCE NOTE

Inverted balance depends on pressure control through the hands; walking adds repeated base reconstruction.

CREDIBILITY & CAUTION

Do not chase speed before step placement is predictable.

Chapter 126

Shoulder shift and single-arm support

ADVANCED **COACH**

A handstand walk contains repeated moments of partial single-arm support. The shoulder must shift without the trunk collapsing or twisting excessively.

Shoulder taps are a useful bridge only when done with line control. Wild hip rocking during shoulder taps often predicts poor walking mechanics.

The coach should progress from wall shoulder taps to box taps, then free weight shifts, then step timing.

Table VIII.4. Single-arm readiness

Task	Green sign	Red sign
Wall shoulder tap	Minimal hip shift	Twist/collapse
Box tap	Shoulder pushes tall	Elbow bend
Free weight shift	Pressure controlled	Immediate fall
First step	Recover line	Chase fall

KEY IDEA

Walking requires the shoulder to transfer load without losing the body column.

EVIDENCE NOTE

Handstand apparatus and EMG research supports high shoulder-girdle contribution in inverted support tasks.

CREDIBILITY & CAUTION

Do not add high-volume walking to athletes who cannot perform controlled shoulder taps without pain or collapse.

Chapter 127

Stopping, turning and restarting

ATHLETE **COACH**

A complete handstand walk includes stopping and restarting. An athlete who can only continue until crashing has not mastered dynamic inversion.

Stopping requires reducing forward lean, re-establishing the centre of mass over the hands and exiting if control is not restored.

Turning adds side-to-side pressure demands and should be introduced after straight-line walking is reliable.

Table VIII.5. Control tasks

Task	Purpose	Progression
Walk-stop	Recover static balance	2-3 step repeats
Stop-exit	Safe termination	Lane target
Half-turn	Lateral control	Wide lane and spotter
Restart	Rhythm recovery	Stop 2 s then walk

KEY IDEA

Control is proven by the ability to stop, not just continue.

EVIDENCE NOTE

Dynamic balance principles require control of acceleration, deceleration and direction change, not only distance.

CREDIBILITY & CAUTION

Do not introduce turns in crowded spaces, slippery floors or fatigued athletes without strict boundaries.

Chapter 128

CrossFit, gymnastics and performance demands

COACH ATHLETE

Different environments reward different walking qualities. CrossFit often values distance, speed and fatigue tolerance. Gymnastics and performance contexts may value line, artistry and control. Rehab contexts may avoid walking until tissue capacity is robust.

The coach must match the mechanical target to the sport. A fast fatigue walk is not automatically a good gymnastics walk, and a beautiful static line may not prepare an athlete for competition-style handstand-walk volume.

The MMSx decision is always task-specific: define the task before defining the standard.

Table VIII.6. Context-specific emphasis

Context	Primary demand	Training emphasis
CrossFit	Distance under fatigue	Volume, lane, stop rules
Gymnastics	Control and line	Shape, rhythm, exact placement
Circus/performance	Expression and transitions	Variability and artistry
Rehab/return	Tolerance and confidence	Graded exposure

KEY IDEA

Handstand walking standards must match the sport and the athlete, not internet aesthetics.

EVIDENCE NOTE

Strength and conditioning literature supports specificity: adaptation follows the task, dose and context used in training.

CREDIBILITY & CAUTION

Do not import competitive demands into general fitness clients without capacity screening.

PART VIII reference apparatus

EVIDENCE HIERARCHY

Direct handstand studies are prioritised first; gymnastics, motor-control, strength-training, and clinical load-management literature are used only when they explain mechanisms not yet isolated in handstand-specific trials.

Table R.1. Evidence-to-practice translation audit

Source type	Use in this part	Limit
Direct handstand biomechanics	Balance, CoP/CoM, wrist strategy, press-to-handstand, EMG	Often small samples and expert-biased cohorts
Gymnastics injury / RTP	Wrist, elbow, shoulder, spine loading and return-to-sport logic	Sport-specific, not always transferable to recreational adults
Motor learning	Cueing, feedback, variable practice, skill retention	Requires contextual coaching judgement
Strength and load-management consensus	Progression, tissue adaptation and monitoring	Does not replace individual assessment

Core references used in this part

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018.

Chua, L. K., Jimenez-Diaz, J., Lewthwaite, R., Kim, T., & Wulf, G. (2021). Superiority of external attentional focus for motor performance and learning: Systematic reviews and meta-analyses. Psychological Bulletin, 147(6), 618-645.

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140.

Johnson, A., Meador, M., Bodamer, M., Langford, E., & Snarr, R. L. (2019). Exercise technique: Handstand push-up. Strength & Conditioning Journal, 41(2), 119-123.

Kochanowicz, A., Niespodziński, B., Mieszkowski, J., Marina, M., & Kochanowicz, K. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research.

Lauersen, J. B., Bertelsen, D. M., & Andersen, L. B. (2014). The effectiveness of exercise interventions to prevent sports injuries: A systematic review and meta-analysis of randomised controlled trials. British Journal of Sports Medicine, 48(11), 871-877.

MacDonald, M., Baker, J., & colleagues. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living.

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joints moments profile during straight arm press to handstand in male gymnasts. PLOS ONE, 16(7), e0253951.

Soligard, T., Schwellnus, M., Alonso, J. M., Bahr, R., Clarsen, B., et al. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of injury. British Journal of Sports Medicine, 50(17), 1030-1041.

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405.

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. International Review of Sport and Exercise Psychology, 6(1), 77-104.

Hart, E. (2024). Common upper extremity gymnastics injuries and gymnastic-specific return-to-play protocols. Journal of the Pediatric Orthopaedic Society of North America.

Lloyd, R. S., Faigenbaum, A. D., Stone, M. H., et al. (2014). Position statement on youth resistance training: The 2014 International Consensus. British Journal of Sports Medicine, 48(7), 498-505.

Transition to the next part

Part IX now manages the other side of progression: pain, injury, warning signs and return-to-skill after symptoms.

HS-FIG-069 | Handstand Walk Start Position

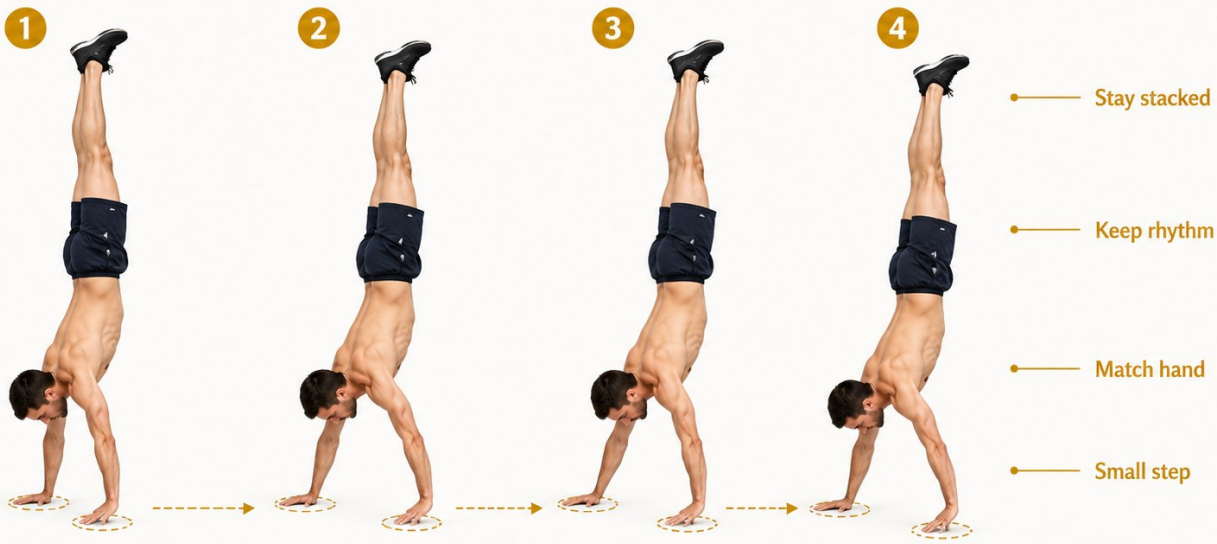


HS-FIG-070 | First Step Mechanics



HS-FIG-071 | Hand Placement During Walking

FIGURE 71 | Hand Placement During Walking



Small, rhythmic hand placements improve balance control and help the athlete keep the line organised during walking.

HS-FIG-072 | Shoulder Shift Timing

FIGURE 72 | Shoulder Shift Timing



Effective handstand walking requires timely shoulder shift so the support arm can accept body mass before the next step.

HS-FIG-073 | Pressure Transfer During Walking

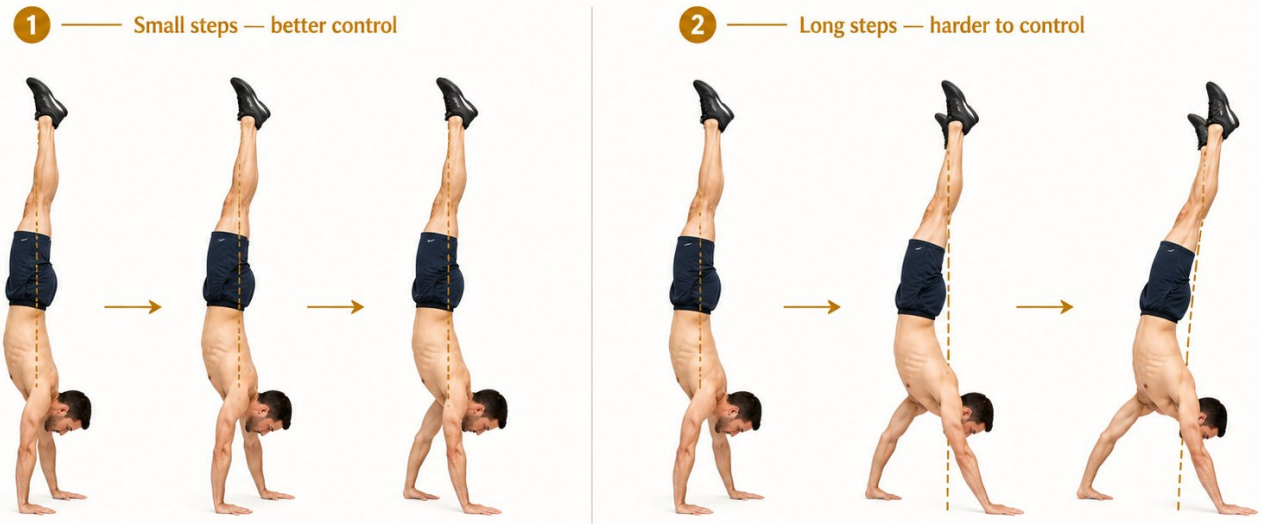
FIGURE 73 | Pressure Transfer During Walking



During handstand walking, one hand acts as the main support while the other becomes the stepping hand and prepares the next placement.

HS-FIG-074 | Small Steps Vs Long Steps

FIGURE 74 | Small Steps vs Long Steps



Shorter steps usually make balance easier to manage, whereas long reaching steps often increase sway and technical breakdown.

HS-FIG-075 | Turning And Stopping

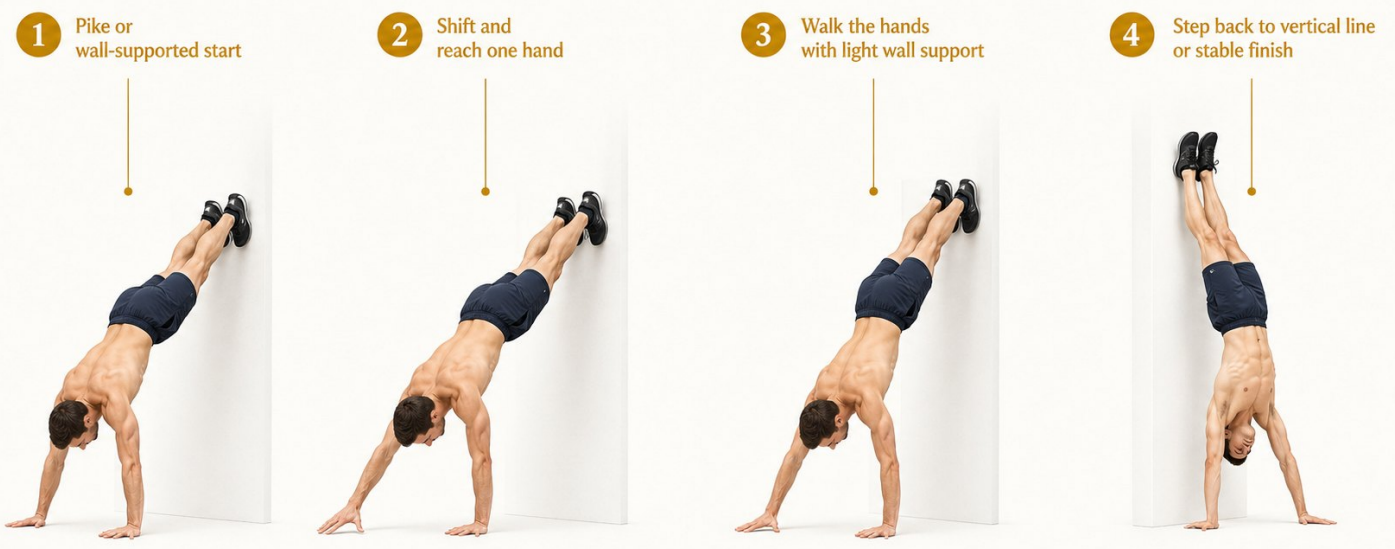
FIGURE 75 | Turning and Stopping



Turning and stopping require the athlete to control direction first, then bring the hands back under the shoulders to finish in a stable line.

HS-FIG-076 | Wall Assisted Walking Drills

FIGURE 76 | Wall-Assisted Walking Drills



Wall assistance can reduce complexity while the athlete learns rhythm, weight transfer and controlled hand placement.

HS-FIG-077 | Partner Assisted Handstand Walking

FIGURE 77 | Partner-Assisted Handstand Walking



A partner can help the athlete explore rhythm and direction, provided the assistance stays light and reduces as control improves.

HS-FIG-078 | Advanced Handstand Walk Variations

FIGURE 78 | Advanced Handstand Walk Variations



Once basic walking is stable, advanced variations can challenge speed, lane precision and directional control.

PART IX

Pain, Injury and Return-to-Skill

Load management, recovery and graded return.



Chapter 143

How handstand injuries happen

CLINICIAN | COACH | ATHLETE

Handstand injuries usually arise from a mismatch between load, position, repetition and tissue capacity. A single fall can cause acute injury, but many problems come from progressive overload without adequate adaptation.

The wrist is exposed to repeated extension and compression, the elbow to long-arm support, the shoulder to overhead loading, and the spine to line-control demands. Fatigue and poor exits magnify the risk.

The professional question is not whether handstands are dangerous. The question is whether the chosen handstand dose matches the athlete today.

Table IX.1. Load-capacity mismatch examples

Region	Common stressor	Capacity decision
Wrist	High-volume extension loading	Reduce angle and volume
Elbow	Repeated locked support	Assess pain and control
Shoulder	Sagging overhead fatigue	Rebuild support endurance
Neck	Poor exit or head position	Modify gaze/exits
Lumbar spine	Banana-line fatigue	Improve rib-pelvis control

KEY IDEA

Injury risk is a load-capacity decision, not a label attached to the skill.

EVIDENCE NOTE

Gymnastics upper-extremity injury literature and IOC load consensus statements support graded exposure and load monitoring.

CREDIBILITY & CAUTION

This book does not diagnose injuries. Persistent, severe or neurological symptoms require qualified medical assessment.

Figure IX-1. Return-to-skill logic after pain.

FIGURE 84 | Return-to-Wall Progression



After symptoms settle, return to wall-supported inversion gradually, building tolerance, line control and confidence step by step.

Chapter 144

Wrist pain patterns and referral logic

CLINICIAN COACH

Wrist discomfort during early loading can reflect adaptation demand, but sharp pain, swelling, loss of function, ulnar-sided symptoms or pain during daily tasks changes the decision.

The first response is not to stretch harder. Reduce load, reduce angle, monitor response, and refer when red flags or persistent symptoms appear.

A return plan rebuilds range, pressure tolerance and inversion exposure separately before combining them again.

Table IX.2. Wrist decision rules

Symptom	Decision
Mild pressure only during loading	Reduce volume and monitor
Sharp pain on extension	Stop loaded extension and assess
Ulnar-sided pain	Refer if persistent or functional
Swelling/loss of grip	Medical review
Next-day escalation	Reduce exposure immediately

KEY IDEA

The wrist is both the base and the steering system; pain here changes every handstand decision.

EVIDENCE NOTE

Common upper-extremity gymnastics injury literature provides wrist-specific return-to-sport protocols and caution around repeated loading.

CREDIBILITY & CAUTION

Do not continue full handstand loading with worsening wrist pain or symptoms that persist outside training.

Figure IX-2. Priority red flags for professional review.

FIGURE 87 | Pain-Monitoring Positions



Pain-monitoring positions can help the athlete and clinician judge tolerance as load rises from simple support to more inverted tasks.

Chapter 145

Elbow pain and lockout stress

CLINICIAN COACH

The elbow may complain when the athlete repeatedly dumps into passive lockout, bends under fatigue or twists during entry and walking.

The first mechanical question is whether the elbow is acting as a stable transmitter or as an emergency hinge. Painful lockout requires load reduction and careful reassessment.

Return should begin with lower-angle pike support, controlled long-arm loading and gradual exposure to inversion.

Table IX.3. Elbow return ladder

Level	Task	Advance when
1	Pain-free range and light support	No daily pain
2	Incline long-arm holds	No lockout symptoms
3	Pike support	Shoulder stays active
4	Wall holds	No symptom rise
5	Freestanding attempts	Controlled exits

KEY IDEA

Elbow pain often reveals poor load transmission or excessive passive reliance.

EVIDENCE NOTE

Handstand systematic findings include elbow involvement as part of mixed control strategies, while gymnastics injury literature highlights upper-extremity stress across the sport.

CREDIBILITY & CAUTION

Pain with instability, trauma or loss of motion is not a coaching problem alone.

Chapter 146

Shoulder pain and overhead loading

CLINICIAN COACH

Shoulder pain in handstand work can reflect insufficient mobility, low support capacity, poor scapular control, excessive volume or inappropriate advanced progressions.

The shoulder must flex, elevate, stabilise and transmit force. If any of these fail, the athlete may compensate through lumbar extension, elbow bend or neck position.

Return should restore pain-free overhead range, active elevation, scapular control, then wall loading before dynamic walking or handstand push-ups.

Table IX.4. Shoulder pain decisions

Finding	Likely decision
Pain overhead unloaded	Clinical assessment before loading
Pain only under fatigue	Reduce volume and restore endurance
Shoulder sag	Rebuild elevation capacity
Pinching with wall line	Modify angle and assess mobility
Pain with instability feeling	Refer

KEY IDEA

The shoulder must be mobile enough to stack and strong enough to support.

EVIDENCE NOTE

Handstand EMG and apparatus studies support the central role of shoulder-girdle musculature in inverted support.

CREDIBILITY & CAUTION

Do not add kipping, walking or handstand push-ups to unresolved shoulder pain.

Chapter 147

Neck and cervical safety

CLINICIAN **COACH**

The neck should not be the load-bearing structure in normal handstand training. Head position should support vision without forcing excessive cervical extension.

Kipping handstand push-ups and failed exits can introduce head or neck contact forces, which require conservative programming and clear standards.

Coaches should teach neutral-ish head control, safe bail options and strict stop rules for any symptom involving dizziness, neurological signs or neck pain.

Table IX.5. Neck safety audit

Risk	Prevention
Head throw in entry	Quiet gaze and wall drills
Crash exit	Teach bail before free attempts
Kipping contact	Strict strength prerequisites
Dizziness	Stop inversion and assess
Neck pain	Remove loading and refer if persistent

KEY IDEA

The neck must guide vision, not absorb the handstand.

EVIDENCE NOTE

Handstand push-up technique literature recognises the skill as a dynamic upper-extremity exercise requiring strength and stability; clinical caution is required for head/neck contact variants.

CREDIBILITY & CAUTION

Dizziness, neurological symptoms, headache after impact, or neck pain after a fall require medical review.

Chapter 148

Return-to-wall, return-to-free and return-to-walk

CLINICIAN | COACH | ATHLETE

Return-to-skill should rebuild exposure in layers. Pain-free daily function does not automatically mean readiness for full handstand walking.

The sequence is range, low load, wall load, controlled wall separation, freestanding entry, short free holds, then dynamic walking. The athlete may stay at any level until response is stable.

Return is successful when the athlete can complete the required exposure and recover without symptom escalation.

Table IX.6. Return-to-skill ladder

Stage	Allowed task	Pass standard
0	No loaded inversion	Symptoms calm
1	Mobility and low-load prep	No next-day rise
2	Pike and incline holds	Pressure tolerated
3	Wall holds	Line and exit safe
4	Heel/toe pulls	Correction safe
5	Freestanding attempts	Bail controlled
6	Walking	Volume recovers

KEY IDEA

Return to handstand is graded exposure plus retesting.

EVIDENCE NOTE

Gymnastics-specific return-to-play literature supports staged return protocols after upper-extremity injury.

CREDIBILITY & CAUTION

Never use pain tolerance as the main return criterion. Pain response, function, confidence and mechanical quality all matter.

PART IX reference apparatus

EVIDENCE HIERARCHY

Direct handstand studies are prioritised first; gymnastics, motor-control, strength-training, and clinical load-management literature are used only when they explain mechanisms not yet isolated in handstand-specific trials.

Table R.1. Evidence-to-practice translation audit

Source type	Use in this part	Limit
Direct handstand biomechanics	Balance, CoP/CoM, wrist strategy, press-to-handstand, EMG	Often small samples and expert-biased cohorts
Gymnastics injury / RTP	Wrist, elbow, shoulder, spine loading and return-to-sport logic	Sport-specific, not always transferable to recreational adults
Motor learning	Cueing, feedback, variable practice, skill retention	Requires contextual coaching judgement
Strength and load-management consensus	Progression, tissue adaptation and monitoring	Does not replace individual assessment

Core references used in this part

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018.

Chua, L. K., Jimenez-Diaz, J., Lewthwaite, R., Kim, T., & Wulf, G. (2021). Superiority of external attentional focus for motor performance and learning: Systematic reviews and meta-analyses. Psychological Bulletin, 147(6), 618-645.

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140.

Johnson, A., Meador, M., Bodamer, M., Langford, E., & Snarr, R. L. (2019). Exercise technique: Handstand push-up. Strength & Conditioning Journal, 41(2), 119-123.

Kochanowicz, A., Niespodziński, B., Mieszkowski, J., Marina, M., & Kochanowicz, K. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research.

Lauersen, J. B., Bertelsen, D. M., & Andersen, L. B. (2014). The effectiveness of exercise interventions to prevent sports injuries: A systematic review and meta-analysis of randomised controlled trials. British Journal of Sports Medicine, 48(11), 871-877.

MacDonald, M., Baker, J., & colleagues. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living.

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joints moments profile during straight arm press to handstand in male gymnasts. PLOS ONE, 16(7), e0253951.

Soligard, T., Schwellnus, M., Alonso, J. M., Bahr, R., Clarsen, B., et al. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of injury. British Journal of Sports Medicine, 50(17), 1030-1041.

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405.

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. International Review of Sport and Exercise Psychology, 6(1), 77-104.

Hart, E. (2024). Common upper extremity gymnastics injuries and gymnastic-specific return-to-play protocols. Journal of the Pediatric Orthopaedic Society of North America.

Lloyd, R. S., Faigenbaum, A. D., Stone, M. H., et al. (2014). Position statement on youth resistance training: The 2014 International Consensus. British Journal of Sports Medicine, 48(7), 498-505.

Transition to the next part

Part X now converts the entire book into coaching systems, programmes, assessments, cue libraries, templates and a professional reference apparatus.

HS-FIG-079 | Wrist Overload Patterns

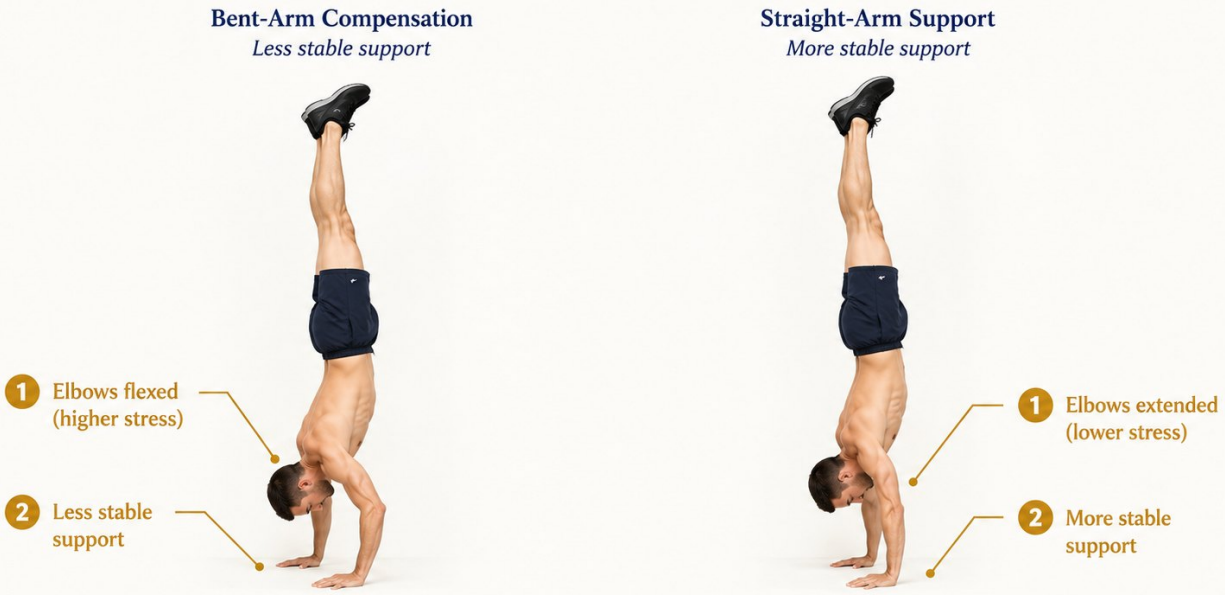
FIGURE 79 | Wrist Overload Patterns



When the wrist position is poorly organised, stress on local structures rises; a better stacked loading pattern usually distributes force more effectively.

HS-FIG-080 | Elbow Stress And Bent Arm Compensation

FIGURE 80 | Elbow Stress and Bent-Arm Compensation



Bent-arm compensation can increase local stress and reduce line control, whereas a stronger straight-arm position usually improves support and stability.

HS-FIG-081 | Shoulder Pain Pattern Collapsed Overhead Support

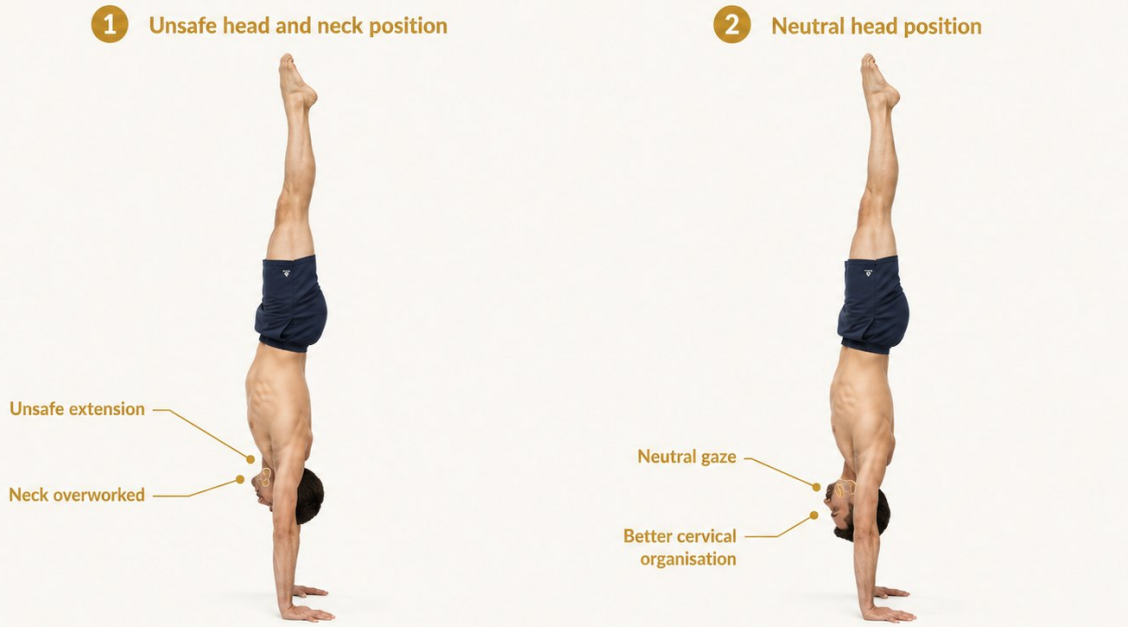
FIGURE 81 | Shoulder Pain Pattern: Collapsed Overhead Support



Collapsed overhead support can increase local shoulder stress; active elevation and a better stacked line usually improve support quality.

HS-FIG-082 | Neck And Head Position Warning Signs

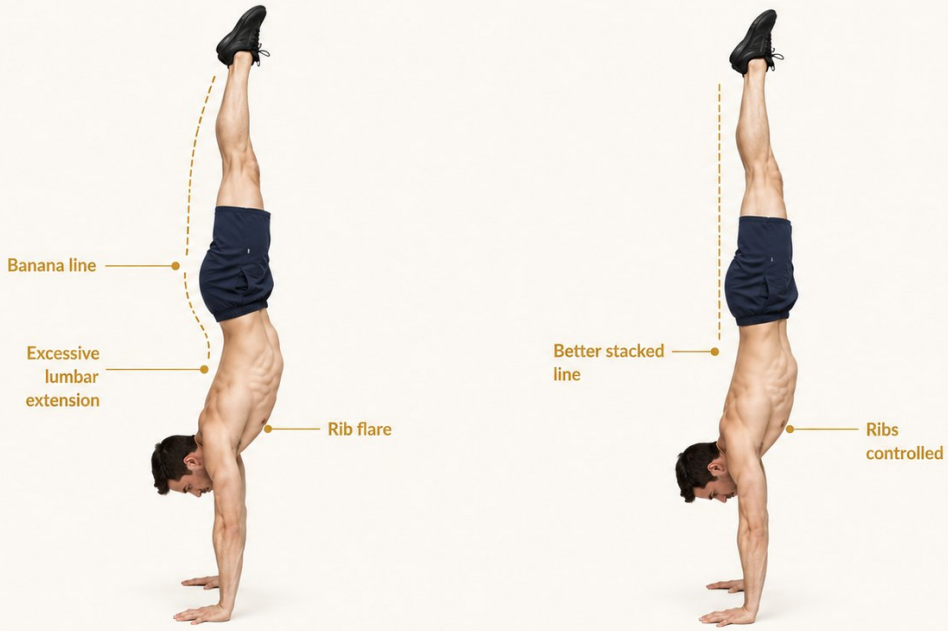
FIGURE 82 | Neck and Head-Position Warning Signs



Excessive neck extension can disturb balance and increase local strain; a neutral head position usually improves line control.

HS-FIG-083 | Low Back Extension Intolerance Banana Overload

FIGURE 83 | Low-Back Extension Intolerance / Banana Overload



Excessive lumbar extension can raise local demand and reduce line efficiency; a more controlled stack often distributes load better.

HS-FIG-084 | Return To Wall Progression

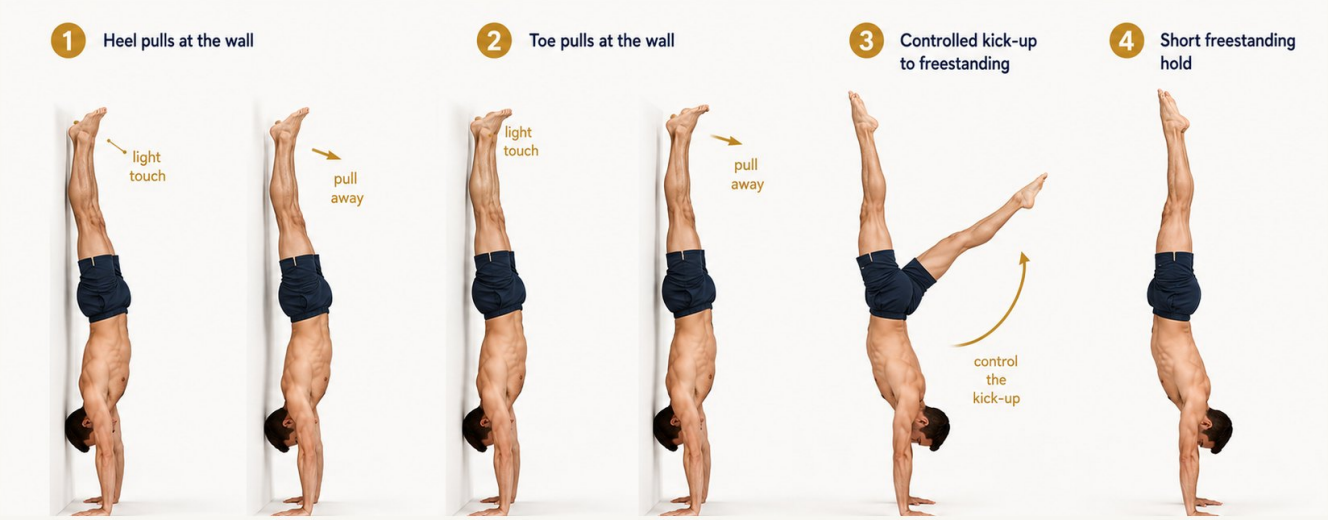
FIGURE 84 | Return-to-Wall Progression



After symptoms settle, return to wall-supported inversion gradually, building tolerance, line control and confidence step by step.

HS-FIG-085 | Return To Freestanding Progression

FIGURE 85 | Return-to-Freestanding Progression



Return from wall support to freestanding balance only after each step is calm, repeatable and symptom-free.

HS-FIG-086 | Return To Walking Progression

FIGURE 86 | Return-to-Walking Progression



Reintroduce walking gradually by restoring stable support, then controlled weight shift, then small steps before longer sequences.

HS-FIG-087 | Pain Monitoring Positions

FIGURE 87 | Pain-Monitoring Positions



Pain-monitoring positions can help the athlete and clinician judge tolerance as load rises from simple support to more inverted tasks.

HS-FIG-088 | Confidence Rebuilding After Pain

FIGURE 88 | Confidence Rebuilding After Pain



Confidence often returns best when support is reduced gradually and each small success is repeated under control.

PART X

PROGRAMMING, COACHING AND REFERENCE APPARATUS

Assess, coach, cue and review.



Chapter 159

Principles of progression

COACH ATHLETE

Programming handstands is the art of selecting the right balance problem at the right dose. Progression is not simply harder drills; it is better matching between goal, capacity and recovery.

Every programme should define the target skill, current limiting factor, exposure volume, stop rules, retest date and criteria for progression.

The MMSx coaching cycle is assess, choose drill, dose, observe, retest, and progress or regress.

Table X.1. Progression variables

Variable	Example	Risk if rushed
Load angle	Pike to vertical	Wrist/shoulder overload
Duration	10 s to 30 s	Fatigue collapse
Complexity	Wall to free	Unsafe falls
Velocity	Hold to walk	Loss of control
Volume	Few attempts to many	Overuse symptoms

KEY IDEA

Progression is a loop, not a ladder drawn once.

EVIDENCE NOTE

Resistance-training and load-management literature support planned progression, monitoring and individual response.

CREDIBILITY & CAUTION

Do not progress multiple variables at once unless the athlete has robust capacity and the purpose is deliberate challenge.

Figure X-1. MMSx coaching cycle.

FIGURE 89 | Coaching View Positions



Different camera and coaching views reveal different mechanical information, so front, side and rear perspectives should all be checked.

Chapter 160

Beginner eight-week on-ramp

BEGINNER COACH

The beginner programme builds wrist base, pike support, wall confidence, line awareness and exit skill. It does not chase freestanding success before safety exists.

Sessions should be short and high quality. Two to four exposures per week are enough for many beginners, depending on wrist response, training age and other loading.

The goal at week eight is not guaranteed freestanding mastery. The goal is a safe, educated athlete with a repeatable wall line and beginning balance drills.

Table X.2. Eight-week on-ramp

Weeks	Primary focus	Main drills
1-2	Base and wrist tolerance	Quadruped rocks, incline leans
3-4	Pike support	Box holds, scap pushes
5-6	Wall line and exit	Wall walks, chest-to-wall, bail
7-8	Controlled separation	Heel pulls, toe pulls, short kick-ups

KEY IDEA

The beginner on-ramp teaches the body and nervous system to trust inversion.

EVIDENCE NOTE

Youth and adult resistance-training guidance supports supervised, progressive loading with technique emphasis.

CREDIBILITY & CAUTION

Adjust volume downward for wrist-sensitive, deconditioned or anxious athletes.

Chapter 161

Twelve-week freestanding plan

ATHLETE	COACH

The freestanding plan develops entry accuracy, pressure correction, clean exits and increasing duration. It should be built around clean attempts rather than fatigue punishment.

Each week should include wall line maintenance, correction drills, freestanding attempts and a small amount of capacity work.

The athlete should record clean attempts, best quiet hold, major saves, exit quality and symptom response.

Table X.3. Weekly freestanding template

Block	Content	Purpose
Warm-up	Wrist/shoulder/trunk prep	Prepare tissues
Line	Wall holds/heel pulls	Maintain shape
Skill	Freestanding attempts	Entry and correction
Capacity	Pike or wall endurance	Support reserve
Retest	Best quiet hold	Track progress

KEY IDEA

Freestanding progress comes from classified attempts and controlled correction.

EVIDENCE NOTE

Motor-learning research supports feedback, practice structure and variable exposure for skill acquisition.

CREDIBILITY & CAUTION

Do not use max attempts as the main volume metric; failed attempts can become the largest load in the session.

Figure X-2. Reference apparatus assessment dashboard.

FIGURE 90 | Video-Analysis Key Frames



Capture entry, catch, stack, correction, hold and exit so the mechanical decisions can be reviewed clearly.

Chapter 162

Handstand-walk specialisation block

ADVANCED COACH

The walking block should begin only when the athlete can tolerate wall loading, shift weight and exit safely. The first target is controlled steps, not distance records.

Use lanes, stop targets, short walks and rest. Walking volume rises only when shoulder and wrist response remains stable.

The coach should separate straight-line walking, stopping, turning and fatigue walking as different progressions.

Table X.4. Six-week walking block

Weeks	Focus	Dose idea
1	Shoulder taps and lean	Low volume
2	One to three steps	Frequent rest
3	Short lane walks	Stop target
4	Distance accumulation	Quality cap
5	Turns/restarts	Controlled variation
6	Fatigue-specific exposure	Strict stop rules

KEY IDEA

Walking volume must follow single-arm support readiness.

EVIDENCE NOTE

Dynamic task specificity and load-management evidence support gradual exposure to the exact walking demands.

CREDIBILITY & CAUTION

Stop walking practice when the athlete begins to chase the fall rather than recover the line.

Chapter 163

Press-to-handstand foundation block

ADVANCED **COACH**

Press-to-handstand programming should develop compression, shoulder lean tolerance, scapular support and controlled centre-of-mass travel.

It is a slow-strength and balance problem, not merely a flexibility trick. The athlete must learn to shift mass over the hands while keeping the elbows long and the shoulders active.

Use elevated press drills, straddle leans, toe lifts and eccentric control before high-volume floor attempts.

Table X.5. Press block components

Component	Drill	Purpose
Compression	Seated leg lifts	Hip/trunk capacity
Lean	Pike shoulder lean	COM shift
Support	Scapular pike shrug	Shoulder strength
Pattern	Elevated straddle press	Skill transfer
Control	Eccentric negative	Slow tolerance

KEY IDEA

The press is slow centre-of-mass management under straight-arm support.

EVIDENCE NOTE

Straight-arm press-to-handstand joint-moment research supports specific preparation for the joint demands of the skill.

CREDIBILITY & CAUTION

Do not chase press volume in athletes with unresolved wrist or shoulder symptoms.

Chapter 164

Cue translation library

COACH | BEGINNER

A professional cue should change the movement without creating unnecessary fear. Many common cues are useful only after translation into mechanical targets.

The coach should first decide the mechanical problem, then choose the simplest words that direct the athlete to solve it.

A cue that works once should still be tested against the next repetition, not treated as a permanent truth.

Table X.6. Cue translation library

Popular cue	Mechanical translation	Cleaner cue
Push tall	Scapular elevation under load	Push the floor away
Squeeze everything	Create organised trunk-leg tension	Make one long line
Use fingers	Shift pressure forward early	Press fingerprints into the floor
Open shoulders	Increase shoulder flexion without rib flare	Reach tall through the armpits
Stay tight	Reduce unwanted motion	Hold the line, breathe quietly

KEY IDEA

Good cueing is mechanical precision in simple language.

EVIDENCE NOTE

Attentional-focus literature supports careful cue design, with external focus often benefiting motor performance and learning.

CREDIBILITY & CAUTION

Do not give five cues to a beginner under load. Choose the first correction and retest.

Chapter 165

Video-analysis checklist

COACH RESEARCHER

Video should not be used only to make content. It is a diagnostic instrument when the coach knows what to look for.

Record side view for line and shoulder angle, front/back view for symmetry, and a close view of hand placement when pressure strategy is the question.

Each review should end with one correction, one drill and one retest.

Table X.7. Video checklist

View	Best for	Question
Side	Line, shoulder angle, entry	Where does drift begin?
Front/back	Symmetry, hand width	Is there rotation?
Close hand	Base and fingers	Is pressure active?
Walking lane	Step timing	Can the athlete stop?

KEY IDEA

Video becomes useful when it answers a defined mechanical question.

EVIDENCE NOTE

Biomechanical analysis of handstand studies relies on kinematic and kinetic variables; field video is a simplified but useful coaching translation.

CREDIBILITY & CAUTION

Do not diagnose medical conditions from video. Video identifies movement behaviour, not tissue pathology.

Chapter 166

Final assessment sheets and global standard

COACH | CLINICIAN | RESEARCHER

The final professional standard is not a single test. It is a complete profile of base, line, support, correction, exit, dose and transfer.

A beginner may pass the beginner standard without a freestanding handstand. An advanced athlete may fail the advanced standard if they walk far but cannot stop, turn or recover safely.

The MMSx global reference standard is built to protect the athlete and the science: define the task, measure the behaviour, monitor response and progress with evidence.

Table X.8. MMSx handstand standard

Domain	Beginner pass	Advanced pass
Base	Pain-free hand loading	Pressure correction under fatigue
Line	Chest-to-wall shape	Free line under perturbation
Support	Wall hold quality	Single-arm shifts
Correction	Heel/toe pulls	Quiet freestanding correction
Exit	Safe bail	Exit under walking fatigue
Transfer	Short free attempts	Walk/press/HSPU context-specific

KEY IDEA

The globally acceptable handstand standard must be task-specific, measurable and safe.

EVIDENCE NOTE

The combined literature supports a multidimensional approach: biomechanics, motor learning, load management and injury-specific return-to-sport logic.

CREDIBILITY & CAUTION

Do not let social-media distance, duration or aesthetics replace complete assessment.

PART X reference apparatus

EVIDENCE HIERARCHY

Direct handstand studies are prioritised first; gymnastics, motor-control, strength-training, and clinical load-management literature are used only when they explain mechanisms not yet isolated in handstand-specific trials.

Table R.1. Evidence-to-practice translation audit

Source type	Use in this part	Limit
Direct handstand biomechanics	Balance, CoP/CoM, wrist strategy, press-to-handstand, EMG	Often small samples and expert-biased cohorts
Gymnastics injury / RTP	Wrist, elbow, shoulder, spine loading and return-to-sport logic	Sport-specific, not always transferable to recreational adults
Motor learning	Cueing, feedback, variable practice, skill retention	Requires contextual coaching judgement
Strength and load-management consensus	Progression, tissue adaptation and monitoring	Does not replace individual assessment

Core references used in this part

Blenkinsop, G. M., Pain, M. T. G., & Hiley, M. J. (2017). Balance control strategies during perturbed and unperturbed balance in standing and handstand. Royal Society Open Science, 4(7), 161018.

Chua, L. K., Jimenez-Diaz, J., Lewthwaite, R., Kim, T., & Wulf, G. (2021). Superiority of external attentional focus for motor performance and learning: Systematic reviews and meta-analyses. Psychological Bulletin, 147(6), 618-645.

Gautier, G., Marin, L., Leroy, D., & Thouvarecq, R. (2009). Dynamics of expertise level: Coordination in handstand. Human Movement Science, 28(1), 129-140.

Johnson, A., Meador, M., Bodamer, M., Langford, E., & Snarr, R. L. (2019). Exercise technique: Handstand push-up. Strength & Conditioning Journal, 41(2), 119-123.

Kochanowicz, A., Niespodziński, B., Mieszkowski, J., Marina, M., & Kochanowicz, K. (2019). Changes in the muscle activity of gymnasts during a handstand on various apparatus. Journal of Strength and Conditioning Research.

Lauersen, J. B., Bertelsen, D. M., & Andersen, L. B. (2014). The effectiveness of exercise interventions to prevent sports injuries: A systematic review and meta-analysis of randomised controlled trials. British Journal of Sports Medicine, 48(11), 871-877.

MacDonald, M., Baker, J., & colleagues. (2025). Biomechanical analyses of the handstand: A systematic review. Frontiers in Sports and Active Living.

Mizutori, H., Kashiwagi, Y., Hakamada, N., Tachibana, Y., & Funato, K. (2021). Kinematics and joints moments profile during straight arm press to handstand in male gymnasts. PLOS ONE, 16(7), e0253951.

Soligard, T., Schwellnus, M., Alonso, J. M., Bahr, R., Clarsen, B., et al. (2016). How much is too much? International Olympic Committee consensus statement on load in sport and risk of injury. British Journal of Sports Medicine, 50(17), 1030-1041.

Wyatt, H. E., Vicinanza, D., Newell, K. M., Irwin, G., & Williams, G. K. R. (2021). Bidirectional causal control in the dynamics of handstand balance. Scientific Reports, 11, 405.

Wulf, G. (2013). Attentional focus and motor learning: A review of 15 years. International Review of Sport and Exercise Psychology, 6(1), 77-104.

Hart, E. (2024). Common upper extremity gymnastics injuries and gymnastic-specific return-to-play protocols. Journal of the Pediatric Orthopaedic Society of North America.

Lloyd, R. S., Faigenbaum, A. D., Stone, M. H., et al. (2014). Position statement on youth resistance training: The 2014 International Consensus. British Journal of Sports Medicine, 48(7), 498-505.

Transition to the next part

The book now closes with the full MMSx Authority Movement Decision Science model: define the movement, map the force, identify the bottleneck, select the smallest useful drill, dose it, retest it and progress only when the athlete earns the next mechanical problem.

HS-FIG-089 | Coaching View Positions

FIGURE 89 | Coaching View Positions



Different camera and coaching views reveal different mechanical information, so front, side and rear perspectives should all be checked.

HS-FIG-090 | Video Analysis Key Frames

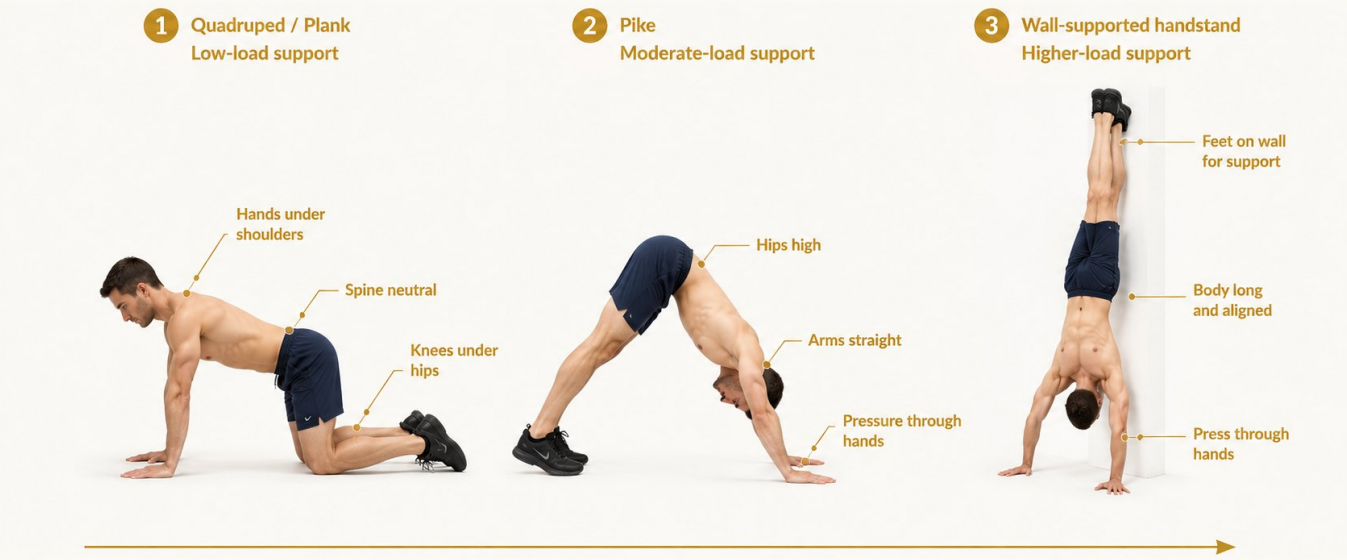
FIGURE 90 | Video-Analysis Key Frames



Capture entry, catch, stack, correction, hold and exit so the mechanical decisions can be reviewed clearly.

HS-FIG-091 | Wrist Capacity Test Positions

FIGURE 91 | Wrist Capacity Test Positions



Use progressive support positions to judge wrist tolerance before moving to longer inverted loading.

HS-FIG-092 | Shoulder Flexion And Overhead Line Assessment

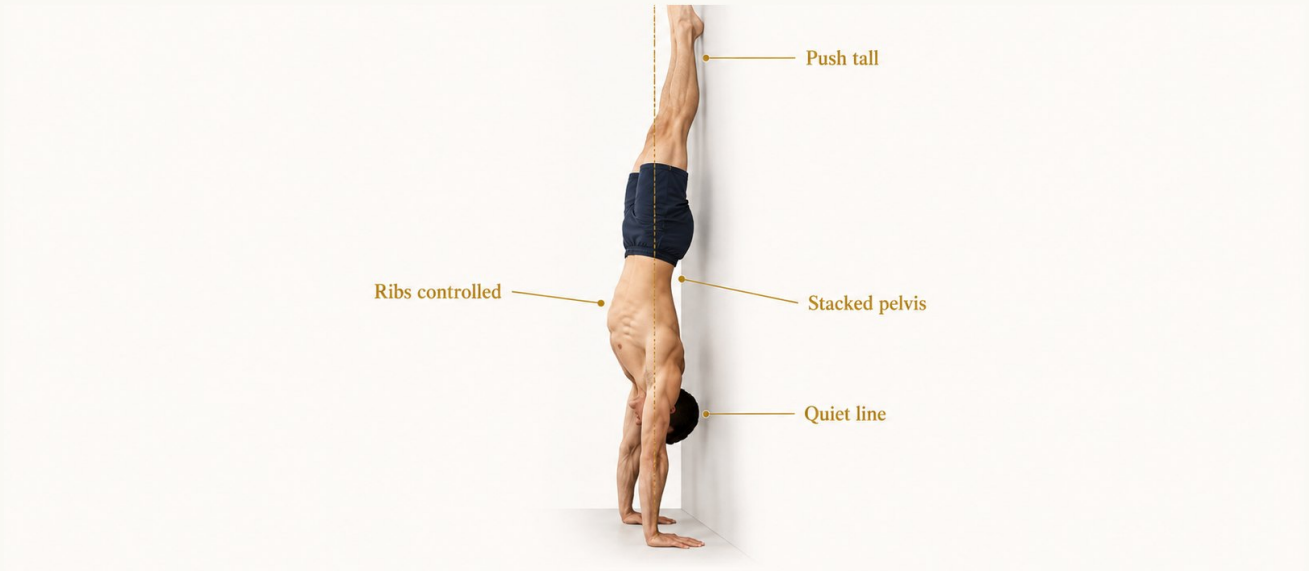
FIGURE 92 | Shoulder-Flexion and Overhead-Line Assessment



Assess whether the athlete can reach overhead without rib flare, lumbar extension or shoulder compensation.

HS-FIG-093 | Wall Line Assessment Figure

FIGURE 93 | Wall-Line Assessment Figure



The wall-line test checks hand placement, shoulder elevation, rib control, pelvis position and the vertical stack.

HS-FIG-094 | Cue Translation Figure

FIGURE 94 | Cue Translation Figure



1 PUSH TALL
Active shoulder elevation, not neck tension.

2 GRIP THE FLOOR
Fingers regulate small balance shifts.

3 RIBS CONTROLLED
Keep the trunk column organised.

4 SQUEEZE LINE
Legs together; long body without stiffness panic.

Translate general coaching phrases into visible mechanical targets so the athlete knows what to organise.

HS-FIG-095 | Common Beginner Faults And First Corrections

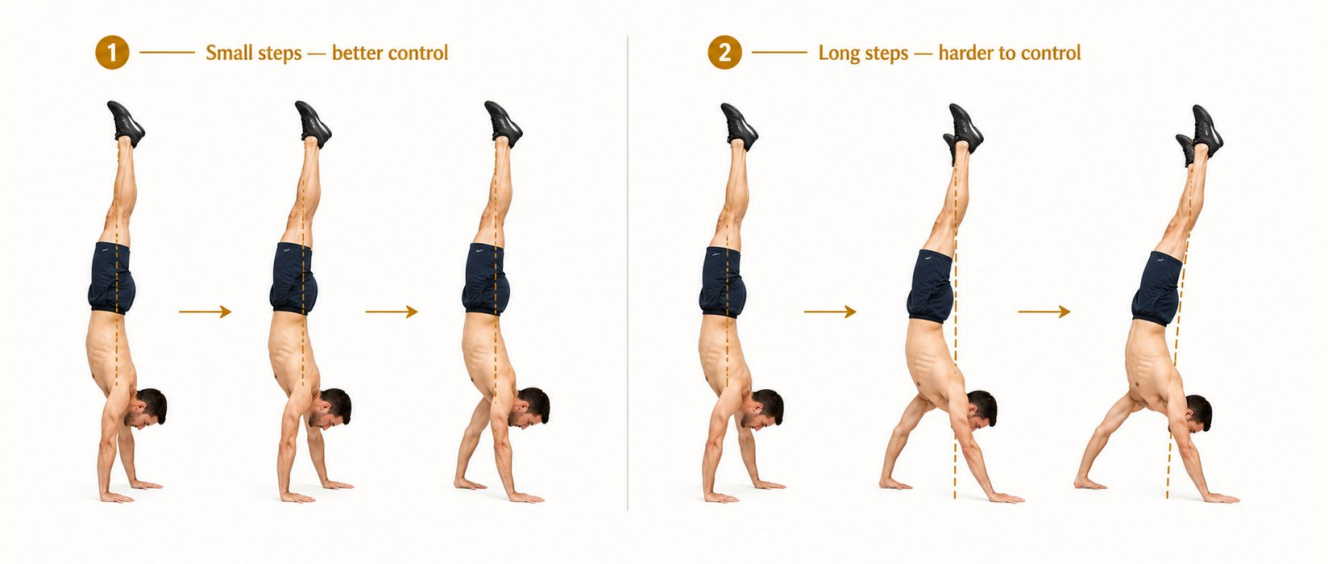
FIGURE 95 | Common Beginner Faults and First Corrections



Beginner errors should be corrected early with one clear mechanical change, then retested in the same task.

HS-FIG-096 | Common Advanced Faults And Refinements

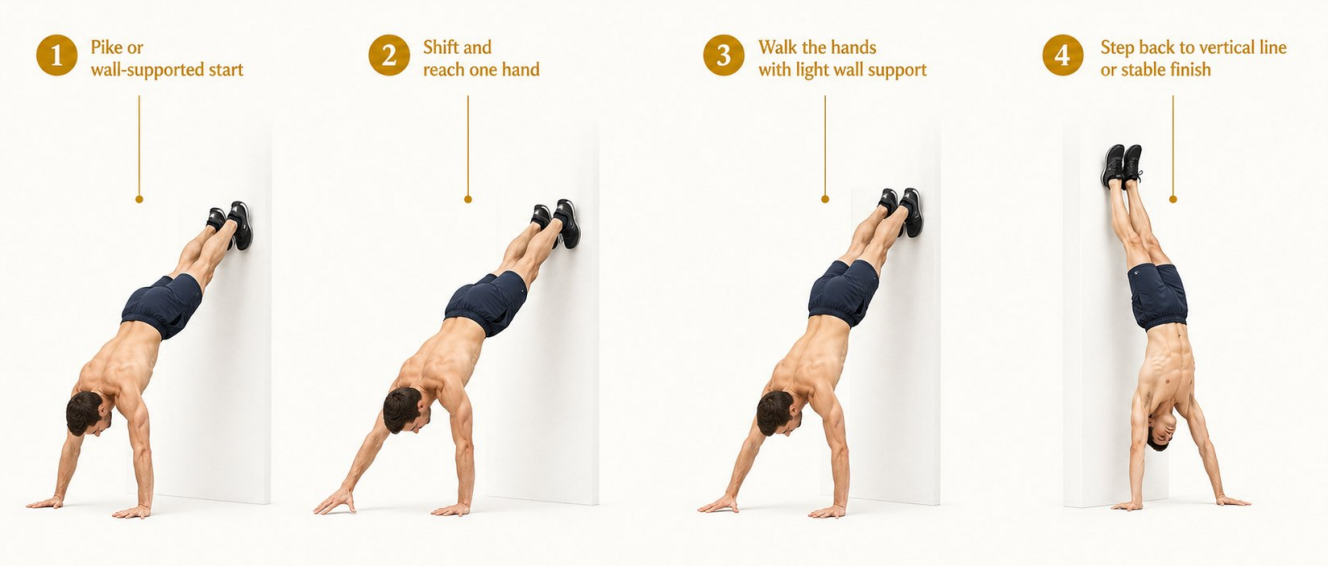
FIGURE 96 | Common Advanced Faults and Refinements



Advanced refinement focuses on rhythm, step size, line control and avoiding large corrections under fatigue.

HS-FIG-097 | Group Coaching Setup

FIGURE 97 | Group Coaching Setup



Group coaching works best when athletes rotate through clear stations for loading, line control, walking rhythm and safe exits.

HS-FIG-098 | Online Coaching Capture Setup

FIGURE 98 | Online Coaching Capture Setup



For online review, capture the entire athlete, hands, feet, entry, hold and exit without cutting off the line.

ABOUT THIS BOOK

Handstand training is more than balance upside down. It is a mechanical decision system of line control, wrist loading, shoulder support, trunk stiffness, pressure regulation and progressive skill exposure.

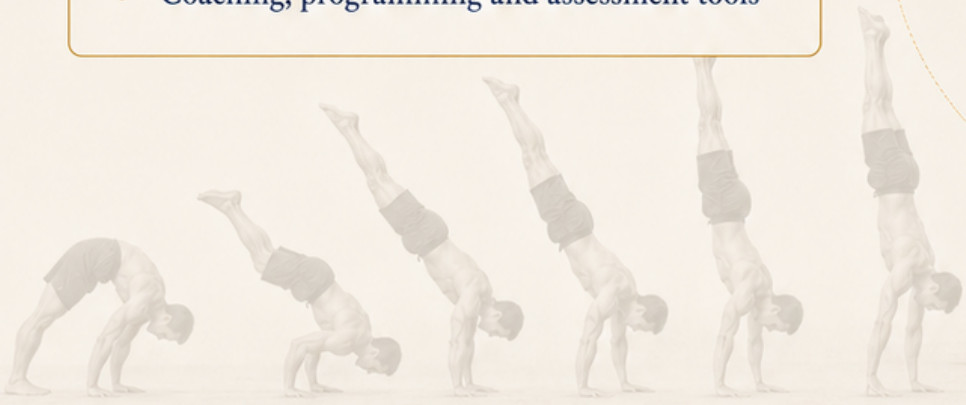
This Global Reference Edition brings together the biomechanics, movement science and coaching logic of the handstand, handstand walk, press-to-handstand and handstand push-up. It is written for athletes, coaches, clinicians, students and researchers who need a credible framework from beginner entry to advanced performance.

Built in the MMSx Authority Movement Decision Science style, this volume links evidence, practical progression, injury reduction and return-to-skill reasoning in one integrated reference.



Inside This Edition

- 10 Parts in one complete reference
- 98 human-figure instructional plates
- Beginner to advanced progressions
- Balance, walking, press and push-up mechanics
- Pain, injury and return-to-skill guidance
- Coaching, programming and assessment tools



IDEAL FOR

Athletes • Coaches • Clinicians • Students • Researchers

MMSx Authority Institute for Movement Mechanics & Biomechanics Research

Global Reference Edition