MICROGATE

POSTURAL CONTROL

TWO CENTERS, ONE SYSTEM

MICRO PILLS

Balance control emerges from the interaction between the Center of Mass (CoM) and the Center of Pressure (CoP).

DEFINITIONS

- **CoM (Center of Mass) – core driven**
  Virtual point representing the distribution of body mass.
- **CoP (Center of Pressure) – pivot driven**
  Resultant point of application of ground reaction forces.

CENTER OF MASS: A DYNAMIC, CORE-CONTROLLED SYSTEM

The human Center of Mass (CoM) **is neither fixed nor associated with a rigid body**; it is the dynamic outcome of a **multi-segmented, mobile, and adaptable system.**

KEY CONCEPTS

- **Humans are not rigid trunks** but assemblies of continuously moving segments.
- CoM position varies according to control of:
  - trunk
  - pelvis
  - limbs
- CoM stability **is not achieved by blocking movement**, but through an **efficient, well-controlled core** capable of coordinating and regulating body segments.

FUNCTIONAL IMPLICATION

The CoM must be **dynamically controlled**, not merely kept "still".

DYNAMIC COM–COP RELATIONSHIP: THE ROLE OF THE CORE

The human CoM is not a rigid trunk: it is mobile, multi-segmented, and adaptable. The CoP moves to keep it controlled.

KEY CONCEPTS

- CoM stability → coordinated control of trunk and pelvis.
- A strong, well-controlled core:
  - anticipates perturbations
  - modulates segments
  - maintains CoM balance
- Foot and ankle → modulate the CoP to compensate for CoM motion.
- Efficient control = load distribution between periphery and center.

PRACTICE

- Training on stable and unstable surfaces
- Biofeedback for awareness and control
- Avoid rigidity; promote adaptive stability

DO NOT SEEK IMMOBILITY, BUT ECONOMICAL AND ADAPTIVE STABILITY

Good stability does not reduce movement; **it optimizes its use.**

COM-COP LINKAGE

- The CoM must remain controllable.
- The CoP oscillates only as much as needed to:
  - anticipate
  - compensate
  - adapt
- Variability is a functional resource.

KEY POINTS

- Excessive rigidity → poor adaptability
- Excessive variability → loss of control
- Training goal: **optimal variability.**

THE SMART FOOT: FINE REGULATOR OF BALANCE AND COP

A smart foot modulates the CoP, simplifies CoM control, and reduces load on the central system.

ROLE OF THE FOOT

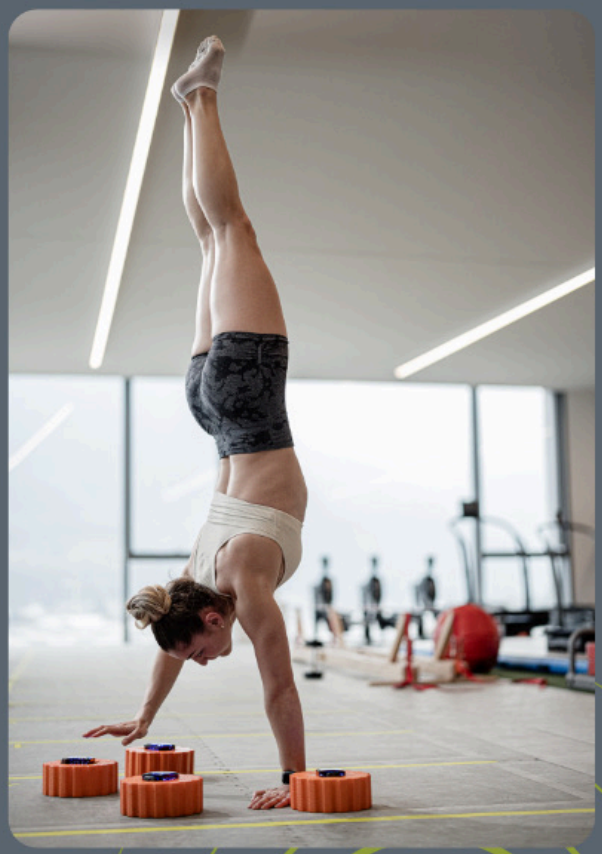
- Rich in cutaneous and proprioceptive receptors
- Primary interface with the ground
- Directly influences:
  - CoP trajectory
  - Balance strategies

BENEFITS

- CoP: more fluid, predictive, less “noisy”
- CoM: more controllable
- Better peripheral control → reduced central demand

THE CORE: PRIMARY REGULATOR OF THE COM

A strong, well-controlled core stabilizes the CoM, coordinates body segments, and reduces load on the central nervous system.



ROLE OF THE CORE

- Coordinates trunk, pelvis, and limbs
- Anticipates perturbations (feedforward)
- Modulates segments to maintain CoM balance

BENEFITS

- CoM more stable, efficient, and controllable
- Reduced need for central corrections
- Supports integrated balance strategies with the foot

WHY TRAIN ON STABLE SURFACES

Stable surfaces allow fine control of the CoM–CoP relationship.

GOALS

Improve:

- CoP symmetry
- low-amplitude control
- postural awareness

Ideal for:

- assessment
- motor learning
- initial biofeedback

WHY TRAIN ON UNSTABLE SURFACES

Unstable surfaces increase the demand for CoP–CoM regulation.

EFFECTS

Increased:

- CoP velocity
- proprioceptive demand

Improved:

- postural feedforward
- perturbation response capacity

STABLE AND UNSTABLE: A FUNCTIONAL PROGRESSION

The system must be educated from fine control to complex adaptation.

PROGRESSION

1. **Stable** → precise CoP control
2. **Unstable** → CoP–CoM adaptation
3. **Functional tasks** → real-world transfer

THE ROLE OF BIOFEEDBACK IN COM–COP CONTROL

Biofeedback makes visible what the nervous system must learn to regulate.

ADVANTAGES

Improve:

- motor learning
- CoP awareness
- CoM control

Transforms assessment into training