What are the features of a stabilogram?
What is stabilogram diffusion analysis?
What is static vs. dynamic postural control?
What aspects of control theory can be used to describe postural control?
COP measurement

COP using force plates

Center of pressure (COP)

Ground reaction force (GRF)
Force plate gives you $\vec{F}$ and $\vec{M}$ and COB location

Notice that $M_y = f(F_x$ and $F_z$)

$$M_y = F_x (z_{off}) + F_z (\text{COP}_x)$$

$$\text{(COP}_x) F_z = M_y - F_x z_{off}$$

$$\text{COP}_x = \frac{M_y - F_x z_{off}}{F_z}$$

(signs & local CS may vary! )
\[ \text{COP}_y = \frac{M_x - z_{off} F_y}{F_z} \]

Quiet stance testing

"stand quietly"

- gaze at fixed target
- \( \sim 30s \) (not too slow!)
- multiple trials (e.g., 10)

Rule of thumb:
5 30s trials

- output COP to evaluate postural sway
Postural sway

A measure of stability

Tool: Stabilogram

Track COP over time

AP displacement (mm)

ML displacement (mm)
COP over time

AP COP (mm)

0  15  30

(time (s))
Effect of pregnancy on balance

Pregnant group:
- n = 15
- 25-38 yrs
- (31 ± 4 yrs)

Non-pregnant control group:
- n = 15
- 26-39 yrs
- (31 ± 4 yrs)

Testing frequency

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- Pre-pregnancy
- Pregnancy: ~ 40 weeks
  - 3 trimesters
- Post-partum: after delivery

Assessments per test session
- 10 trials, 30s, stand quietly with hands to side
- Traditional and SDA balance measures
- Preferred heel stance width
- Perceived sense of balance:
  - 0 ("normal") to 10 ("extremely unstable")
- Fall incidences since last test session

Increasing stance width and perceived balance degradation are coupled with degradations in AP balance

ML sway is modulated by stance width and experience residual effects postpartum
Possible postural control system scenario for upright stance
Stabilogram Diffusion Analysis (SDA)

Brownian motion
The random motion of particles suspended in a fluid resulting from their collision with the quick atoms or molecules in the gas or liquid.

![Simulation of Brownian motion of particles moving in all directions](image)

This is a simulation of the Brownian motion of particles moving in all directions. The particles collide with each other and with the container, resulting in a random distribution of their positions and velocities.
\[(\Delta j)^2 = 2D \Delta t\]
SDA applied to COP

Schematic Representation of Stabilogram-Diffusion Plot

\[ \langle \Delta r^2 \rangle \quad (\text{mm}^2) \]

- Short-Term Region
- Long-Term Region

Critical Point = \((\tau_{rc}, \langle \Delta r^2 \rangle_c)\)

Slope = \(2D_{rs}\)

Slope = \(2D_{rl}\)
**Dynamic Postural Control**

**EquiTest ©**: 18” x 18” dual forceplate with rotation and translation capabilities measure vertical forces exerted by the patient’s feet; and a moveable visual surround.
- *Sensory Organization Test (SOT)*: somatosensory, visual and vestibular systems.
- *Motor Control Test (MCT)*: automatic motor system.

**Proprio 5000 ©**: multi-directional tilting platform to challenge balance. Single ultrasonic marker to record core stability.

Utility for assessing and measuring dynamic balance: under investigation