Posture

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Objective

- Normal posture
- Analyzing different postures
- Kinetics and Kinematics of posture

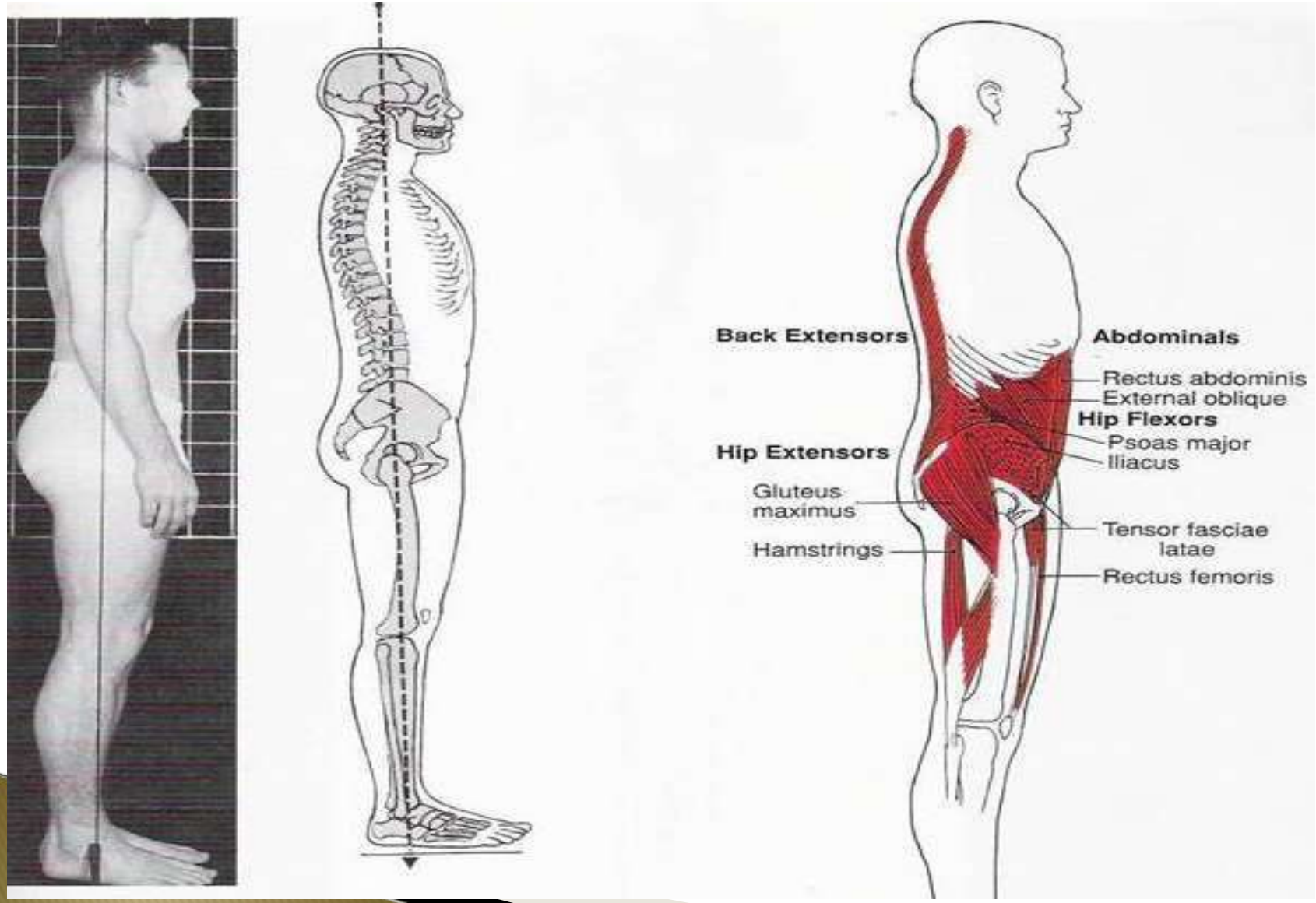
Body Posture

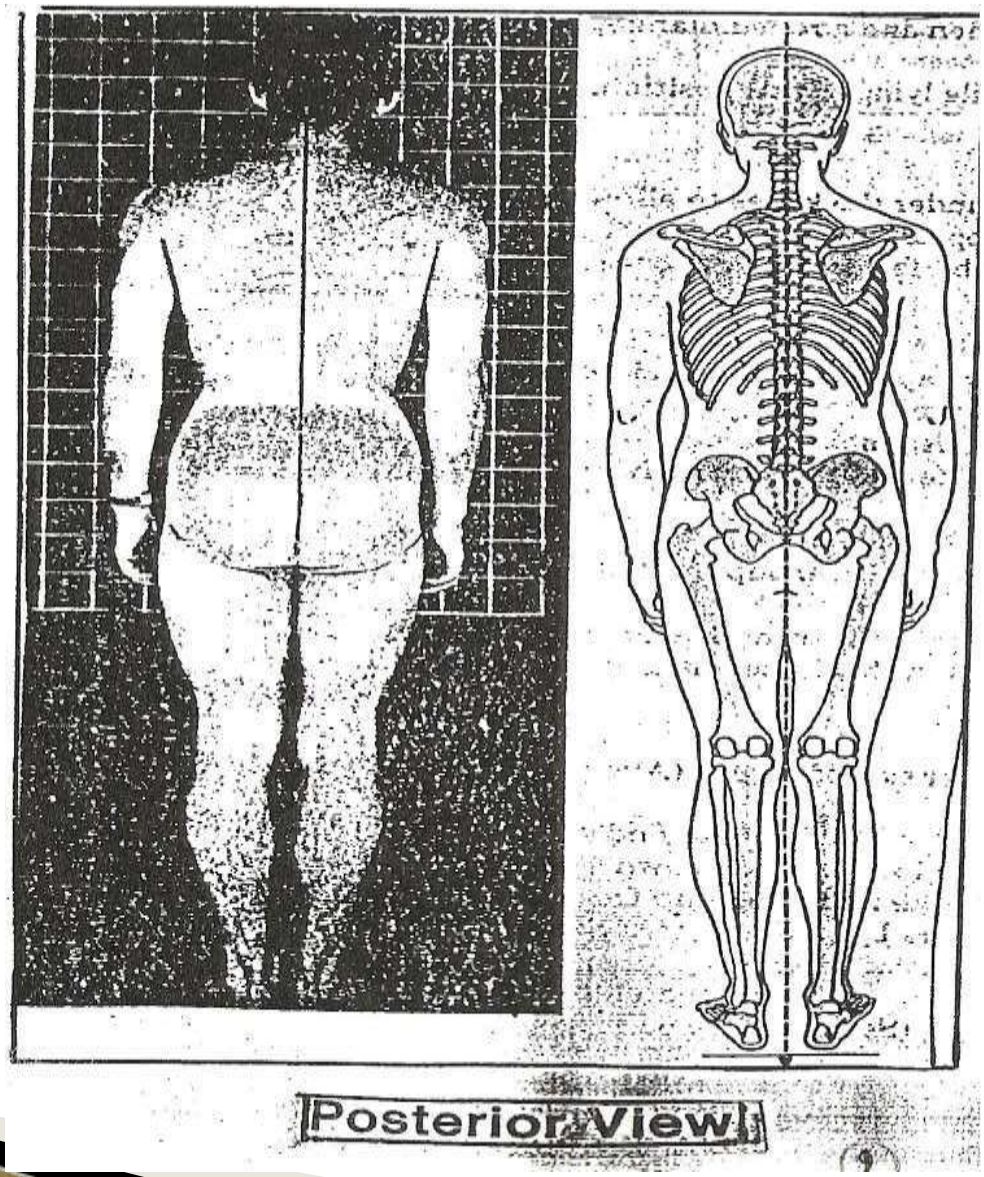
- It is a measure of mechanical efficiency of muscles, balance and of neuromuscular coordination.

- It is considered as the relative arrangement of parts of the body. It changes with the positions and movements of the body throughout life and throughout the day.

- It is the attitude which is assumed by body parts to maintain **stability** and **balance** with minimum effort and least strain during supportive and non supportive positions.

Body posture




Posterior View

Static & Dynamic Postures

Static posture

- The body and its segments are aligned and maintained in certain positions

Dynamic posture

•Refers to postures in which the body or its segments are moving

Postural Control

Static or dynamic

- Refers to a person's ability to maintain stability of the body and body segments in response to forces that threaten to disturb the body's equilibrium
- Reactive (compensatory) responses
- Proactive (anticipatory) responses

Postural Control

- Depend on
  - –somatosensory
  - –Visual system
  - –Vestibular system

Somatosensory system

- Dominant sensory system
- Provides fast input
- Reports information
  - Self-to-(supporting) surface
  - Relation of one limb/segment to another
- Components
  - Muscle spindle
    - » Muscle length
    - » Rate of change
  - GTOs (NTOs)
    - » Monitor tension
  - Joint receptors
    - » Mechanoreceptors
  - Cutaneous receptors

Visual system

- Reports information
  - Self-to-(supporting) surface
  - Head position
    - » Keep visual gaze parallel with horizon
- Subject to distortion

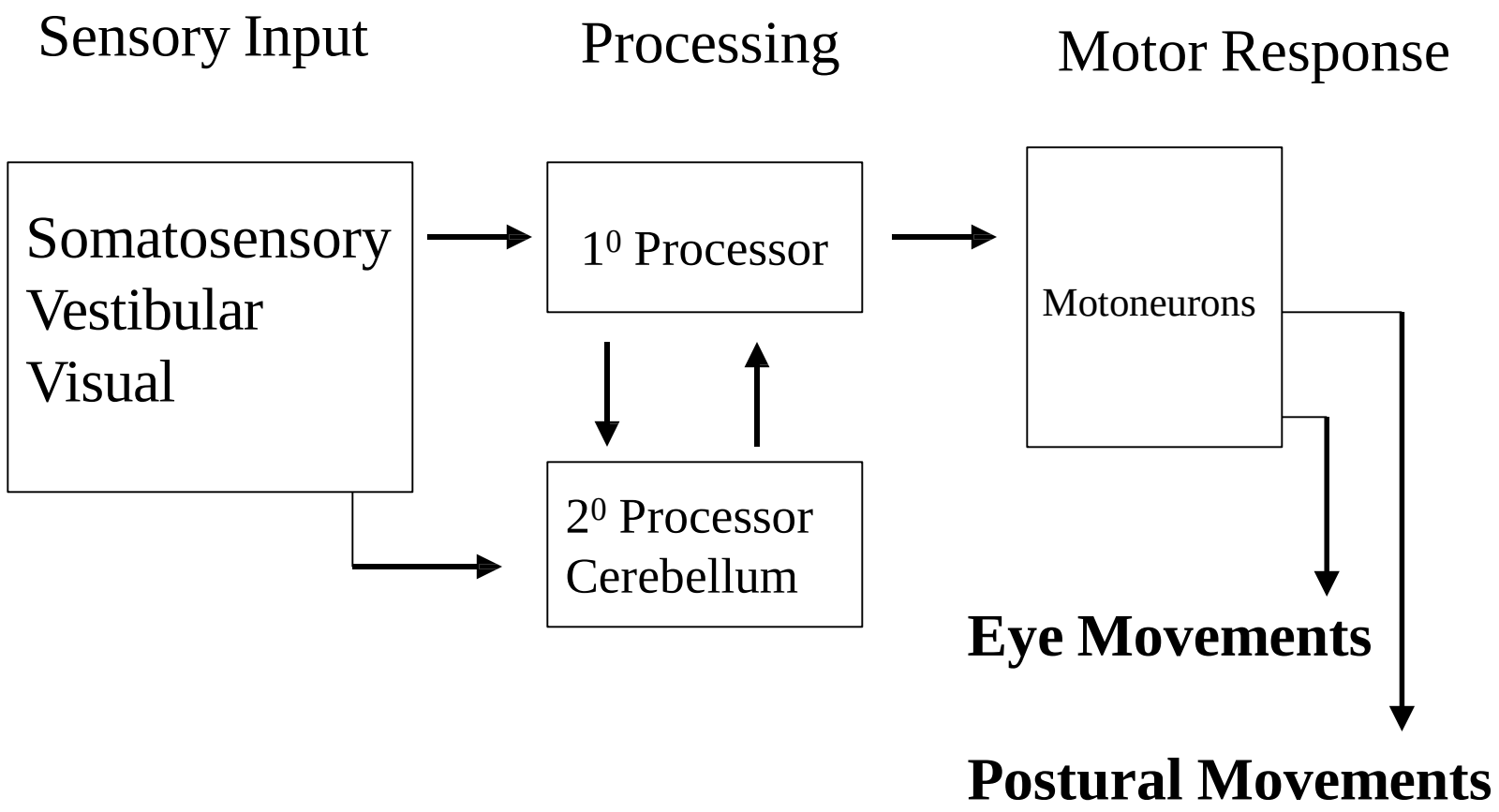
- Components
  - Eye and visual tracts
  - Thalamic nuclei
  - Visual cortex
    - » Projections to parietal and temporal lobes

Vestibular system

- Not under conscious control
- Assesses movements of head and body relative to gravity and the horizon (with visual system)
- Resolves inter-sensory system conflicts
- Gaze stabilization

- Components
  - Cerebellum
  - Projections to:
    - » Brain stem
    - » Ear

Sensory-Motor Integration



Muscle Synergies

- For any particular task many different combinations of muscles may be activated to complete the task
- A normally functioning CNS selects the appropriate combination of muscles to complete the task on the basis of an analysis of sensory inputs

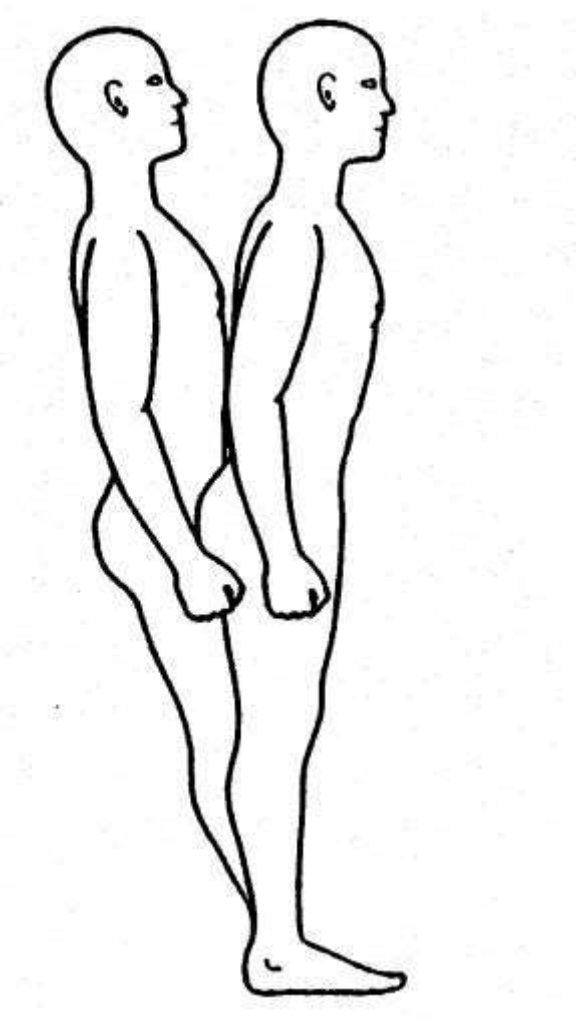
Fixed support synergies

Patterns of muscle activity in which the Base of support(Bos) remains fixed during the perturbation .

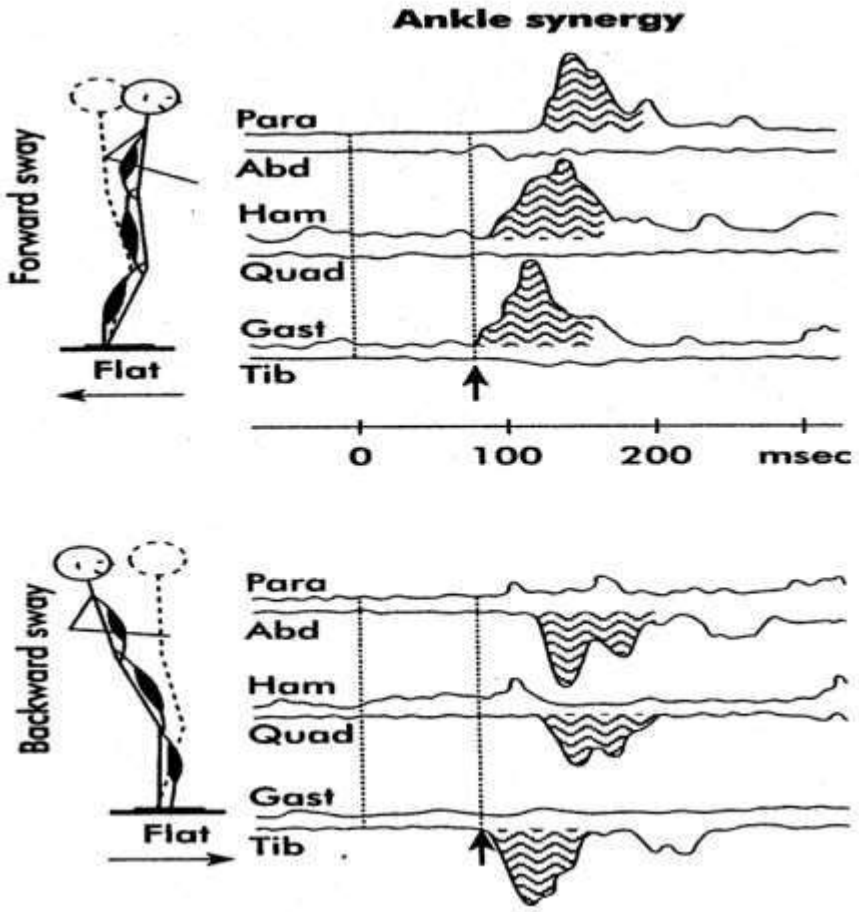
- **Ankle synergy**
- **Hip synergy**

Ankle strategy

- Used when perturbation is
  - Slow
  - Low amplitude
- Contact surface firm, wide and longer than foot
- Muscles recruited distal-to-proximal
- Head movements in-phase with hips

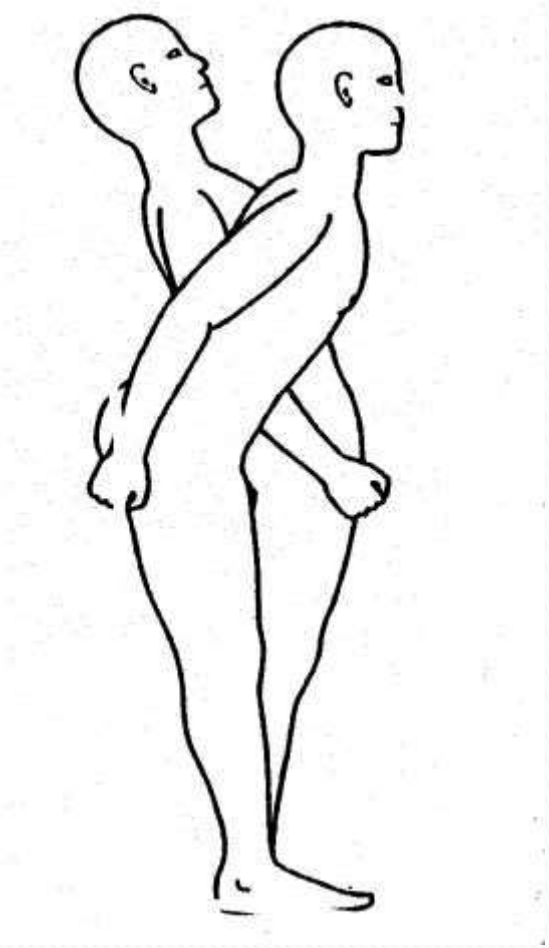


Ankle strategy

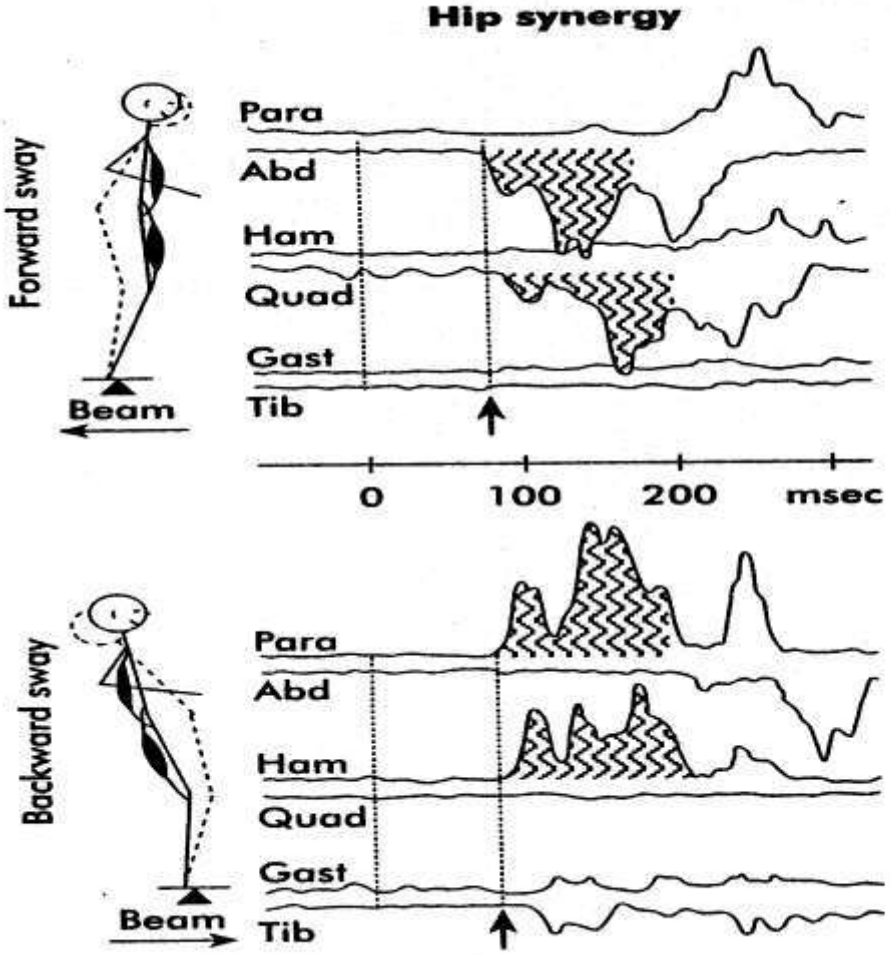


Hip strategy

- Used when perturbation is fast or large amplitude
- Surface is unstable or shorter than feet
- Muscles recruited proximal-to-distal
- Head movement out-of-phase with hips



Hip strategy



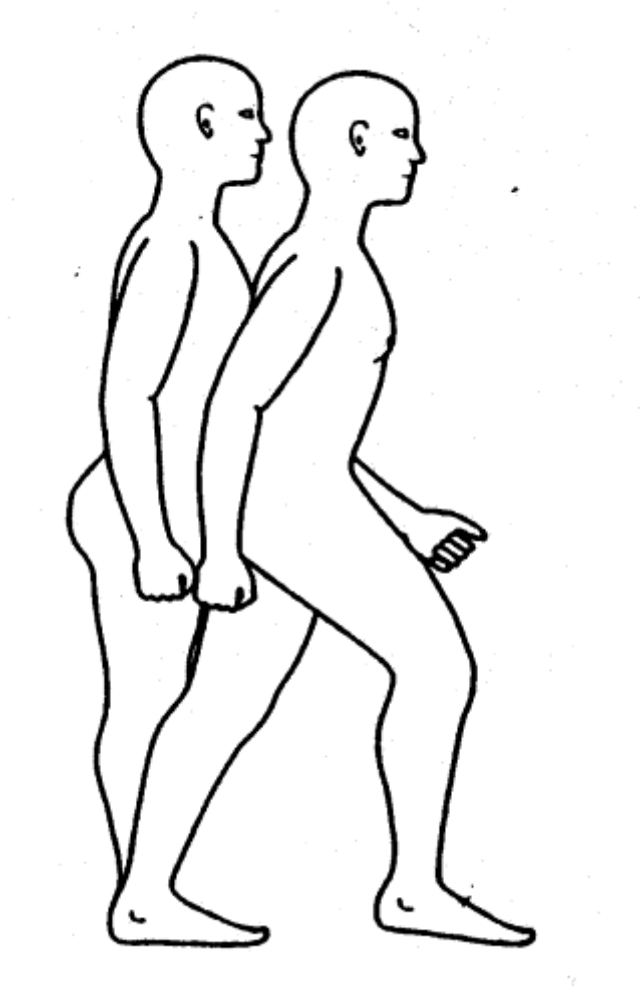
Change in support strategies

- Stepping (forward, backward, sidewise)
  •Grasping

- In response to shift in the BoS.

Stepping strategy

- Used to prevent a fall
- Used when perturbations are fast or large amplitude -or- when other strategies fail
- BOS moves to “catch up with” BOS



Head –stabilizing strategies

- Occur in anticipation of the initiation of internally generated forces caused by changes in position from sitting to standing
- Used to maintain the head during dynamic tasks such as walking
- Strategies
  - –Head stabilization in space
  - –Head stabilization on trunk

Kinematics & Kinetics of posture

- **External forces**
  - Inertia
  - Gravity
  - Ground reaction forces(GRF)
- **Internal forces**
  - Muscle activity
  - Passive tension in ligaments, tendons, joint capsules, soft tissue structures

External Force

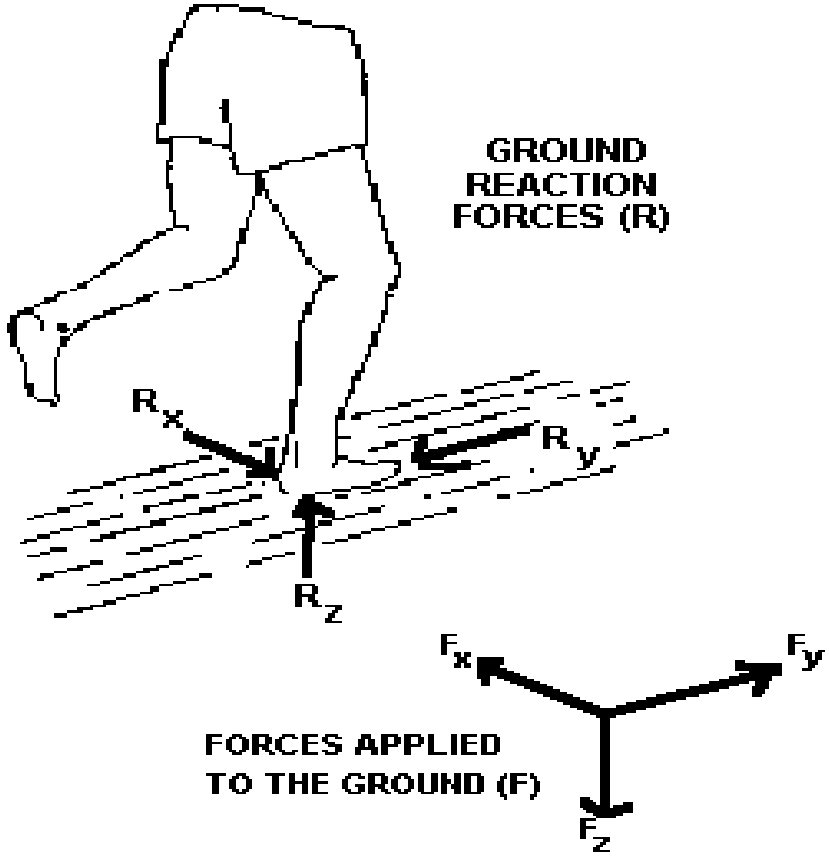
- **Inertial and Gravitational forces**
  - –Body undergoes a constant swaying motion: **postural sway or sway envelope**

External Forces

- **Ground reaction forces**
  - –Resultant force that represents the magnitude and direction of loading applied to one or both feet

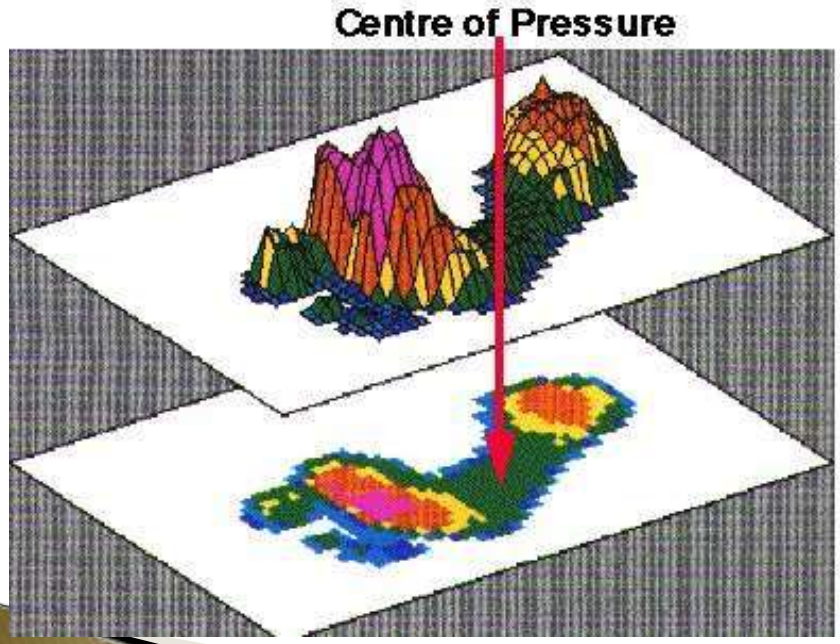
External forces

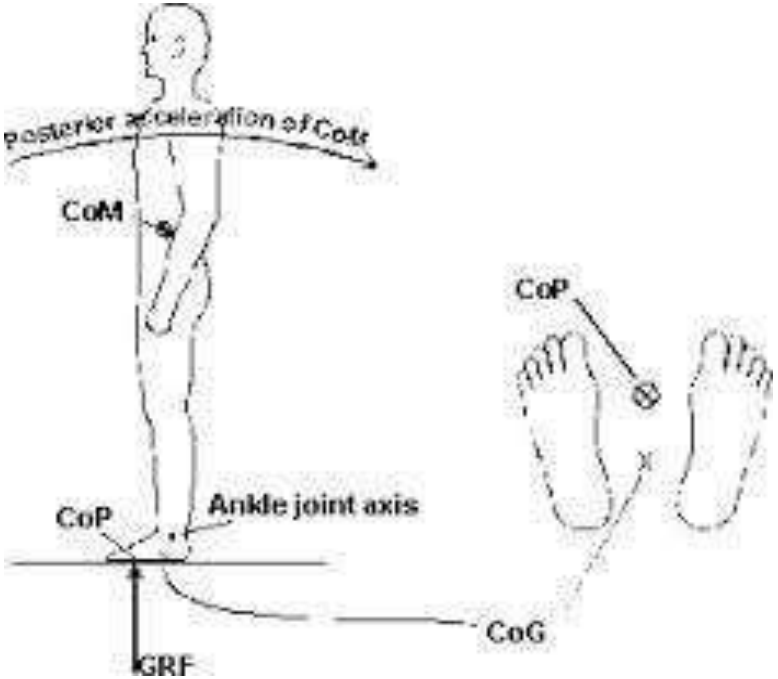
- Ground Reaction force



External forces

- **Centre of Pressure (COP)**
  - Located in the foot in **uni-lateral stance** and between the feet in **bilateral standing** postures.



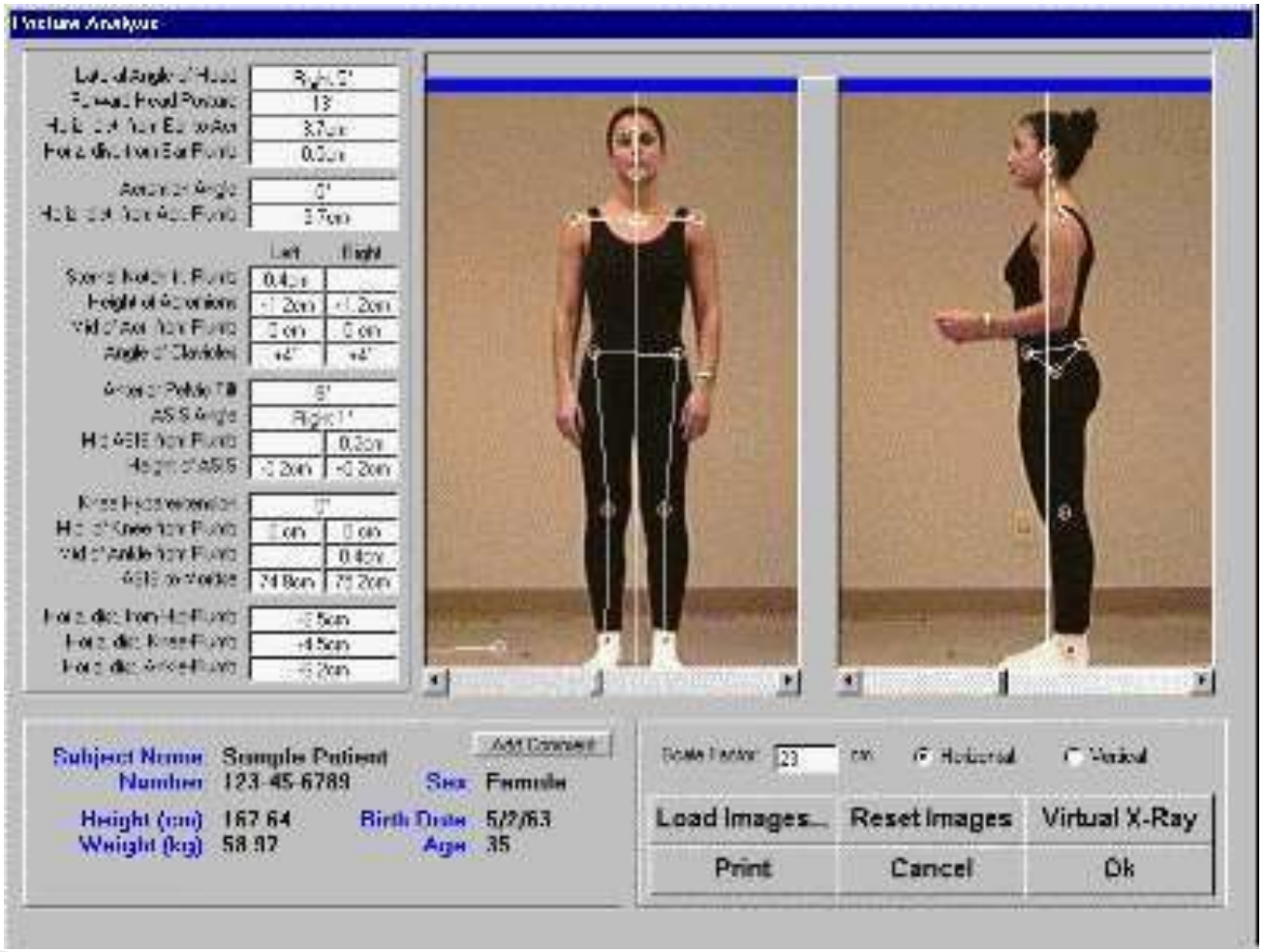


OPTIMAL POSTURE

Optimal Posture

- The LoG is close to most joint axis
- The external gravitational moments are relatively small and can be balanced by internal moments generated by
  - Passive capsular tension
  - Ligamentous tension
  - Passive muscle tension (stiffness)
  - Small amount of muscle activity

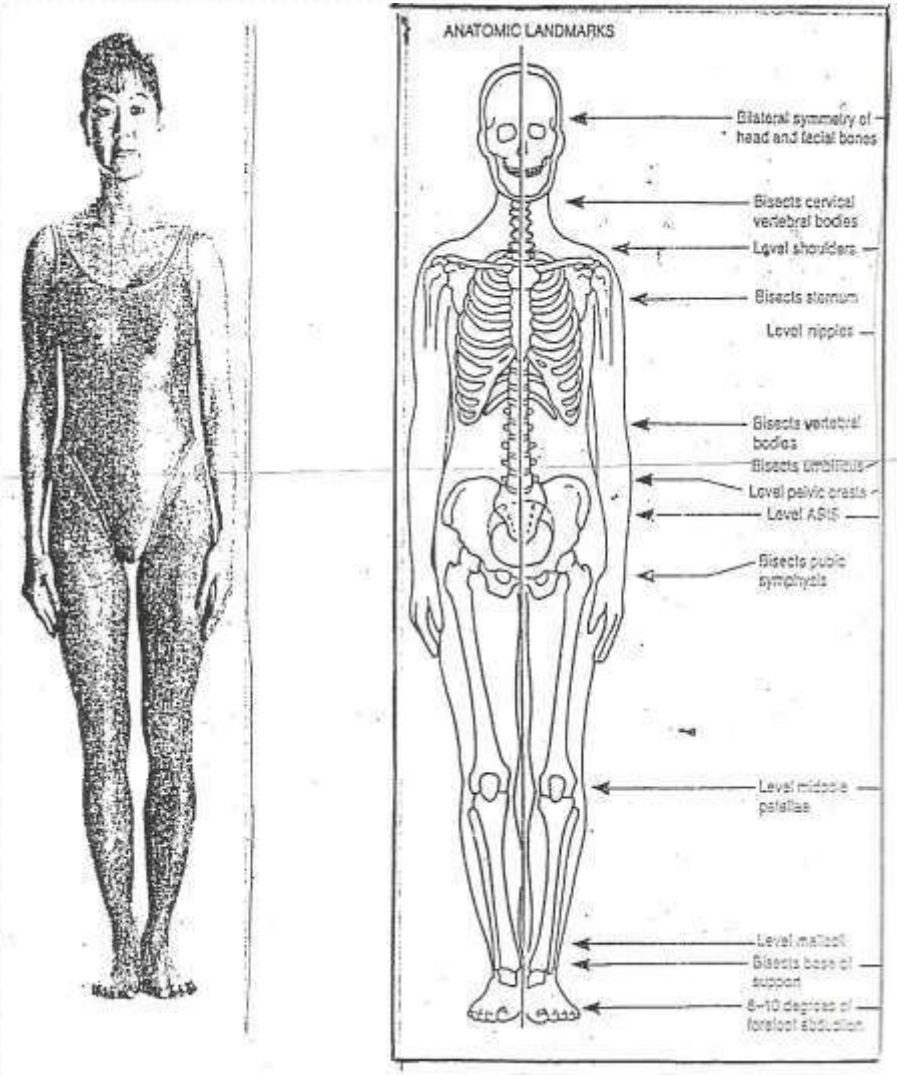
Analysis standing posture



Line of gravity to body segment

From anterior or posterior View:

The line of gravity passes from the vertex through S2 to a point between the two feet in the base of support



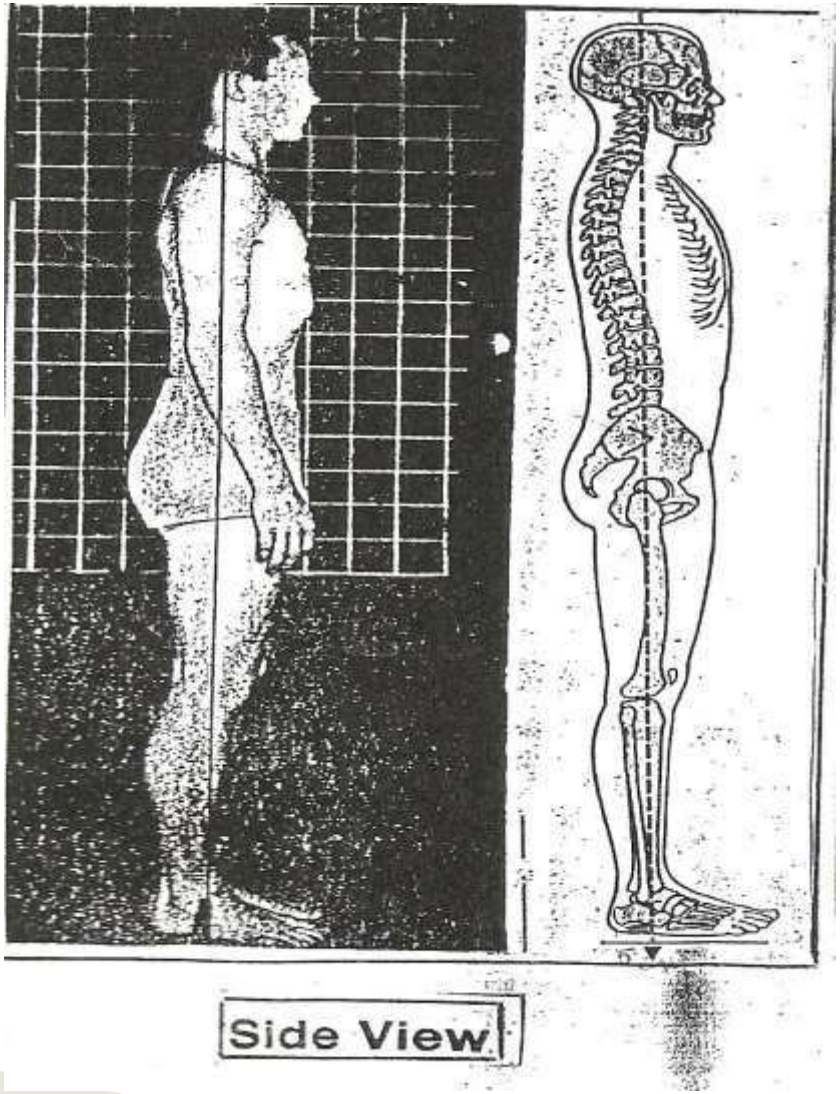
Line of gravity to body segment

From lateral View:

The line of Gravity passes through:

a. Vertex.
b. Mastoid process(behind).
c. Anterior to the axis of flexion and extension of the neck.
d. Acromion Process (bisecting)
e. Body of C1,C6,T11, L5, S1 (it passes posterior to the axes of rotation of the cervical and lumbar vertebrae and anterior to thoracic vertebrae.
a. Via or behind the axis of the hip joint.
b. Anterior to the axis of the knee joint.
c. 5 cm anterior to lateral malleolus.

Lateral view



Analysis Standing Posture

Sagittal plane alignment and analysis

- **Ankle**
  - Neutral position
  - The LoG passes slightly anterior to the lateral malleolus

Analysis of standing posture

Sagittal plane alignment and analysis

- **Knee**
  - Full extension
  - LoG passes anterior to the midline of the knee and posterior to the patella (LoG just anterior to the knee axis)

Analysis of standing posture

Sagittal plane alignment and analysis

- **Hip and pelvis**
  - Hip in neutral position, pelvis is level with no anterior or posterior tilt
  - LoG passes slightly posterior to the axis of the hip joint, through the greater trochanter

Analysis of standing posture

Sagittal plane alignment and analysis

- **Lumbosacral joints**
  - –LoG passes through the body of the **fifth lumbar vertebra**, close to the axis of rotation

of the lumbosacral joint

Analysis standing posture

Sagittal plane alignment and analysis

- **Sacroiliac joints**
  - LoG passes slightly **anterior** to the **sacroiliac joints**
  - Tends to cause the anterior superior portion of the sacrum to **rotate anteriorly and inferiorly**, whereas the posterior inferior portion tends to move **posteriorly and superiorly**

Analysis of standing posture

Sagittal plane alignment and analysis

The vertebral column

–Optimal position of LoG is through the midline of the trunk

Analysis of standing posture

Sagittal plane alignment and analysis

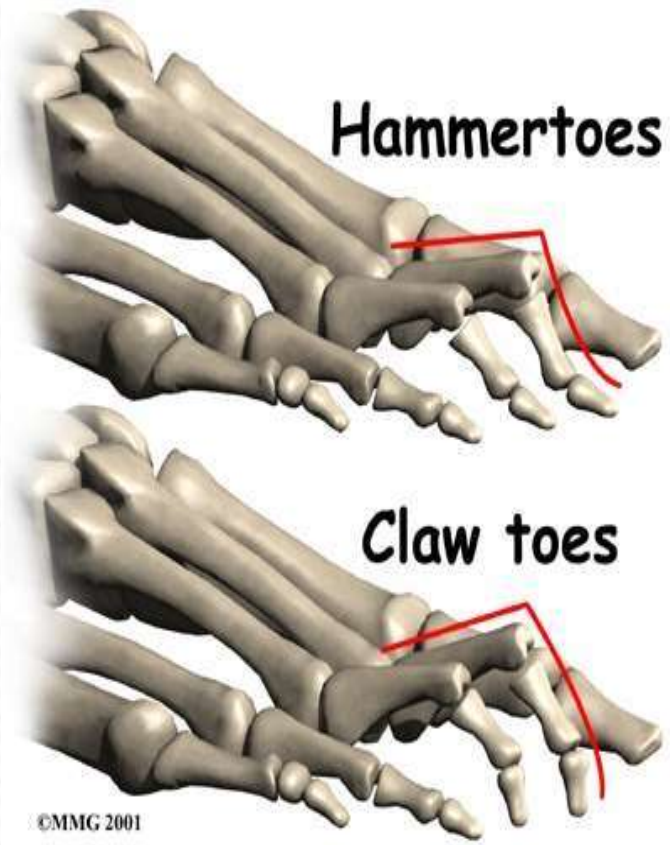
- **Head**
  - –LoG passes slightly anterior to the transverse axis of rotation for flexion and extension of the head

Deviations from optimal alignment in the sagittal plane

- Postural problems may originate in any part of the body
- May cause increase stresses and strains throughout the musculoskeletal system
  •Compensatory postures: postures that represent an attempt to either improve function or normalize appearance

Deviations from optimal alignment in the sagittal plane

- **Foot and toes**
  - –Claw toes: hyperextension of MTP combined with flexion of PIP and DIP
  - –Hammer toes: hyperextension of the MTP joint, flexion of the PIP joint and hyperextension of the PIP joint



Deviations from optimal alignment in the sagittal plane

Kne

e

–Knee flexion contractures

–Hyperextended knee posture (genu recurvatum)

Pelvis

–Excessive anterior pelvic tilt

Deviations from optimal alignment in the sagittal plane

Vertebral column

- –Lordosis and kyphosis
  - Dowager's hump
  - Gibbus (deformity)

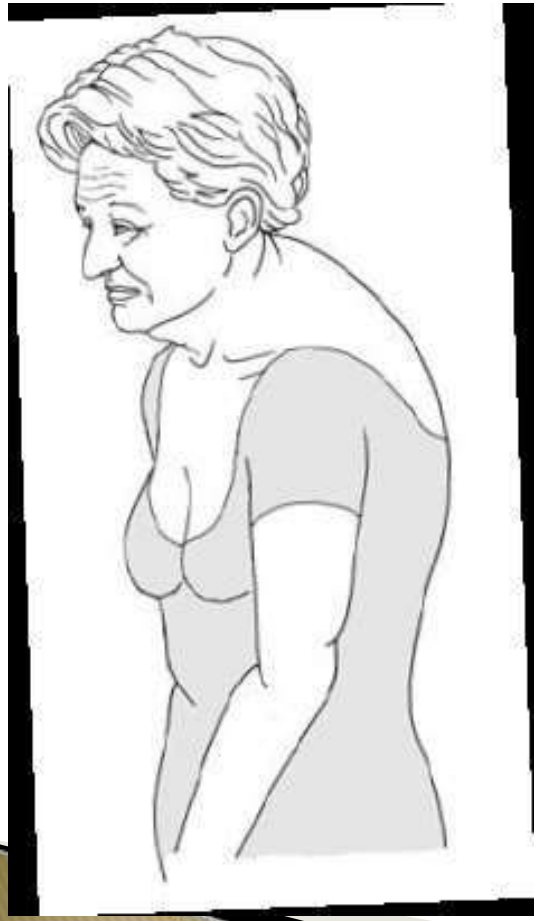
Head

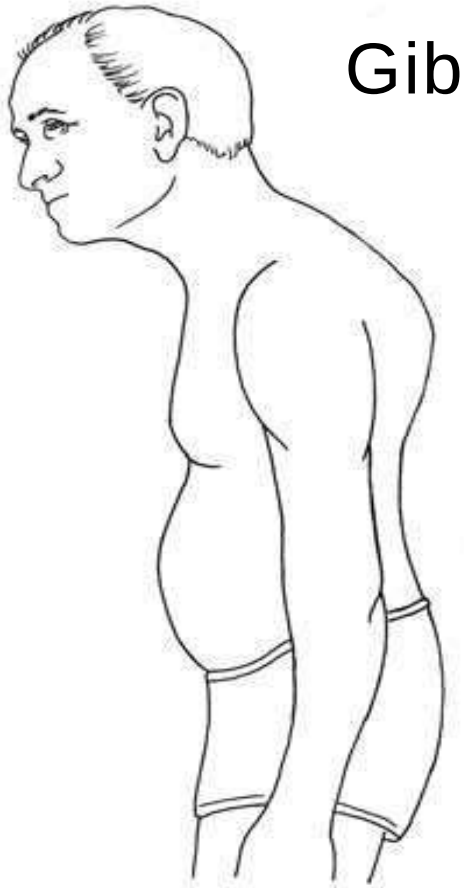
–Forward head posture

- head is positioned anteriorly and the normal anterior cervical convexity is increased with the apex of the lordotic cervical curve at a considerable distance from the LoG in comparison with optimal posture.

Deformities of spine

Dowager's Hump





Gibbus

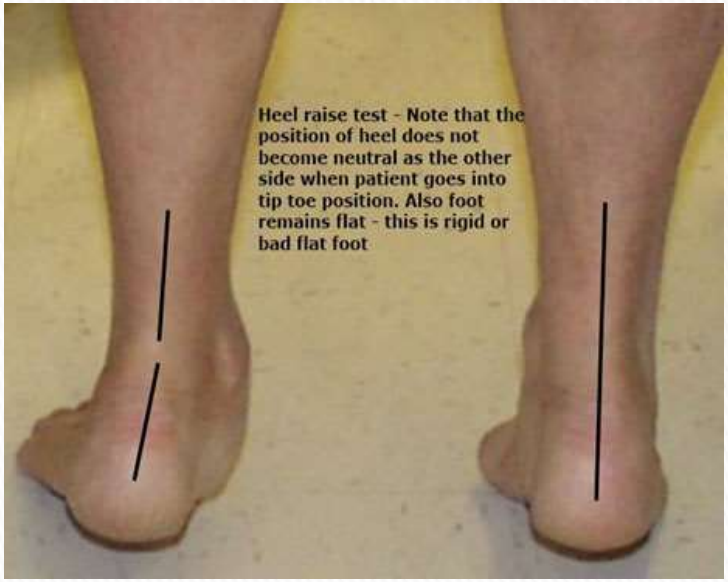
Optimal alignment and analysis

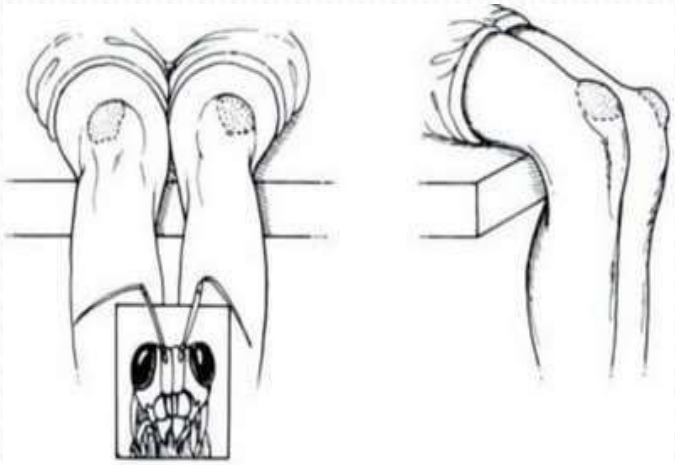
Frontal Plane

- LoG bisects the body into symmetrical halves
- When postural alignment is optimal, little or no muscle activity is required to maintain stability.

Deviations from optimal alignment in the frontal plane

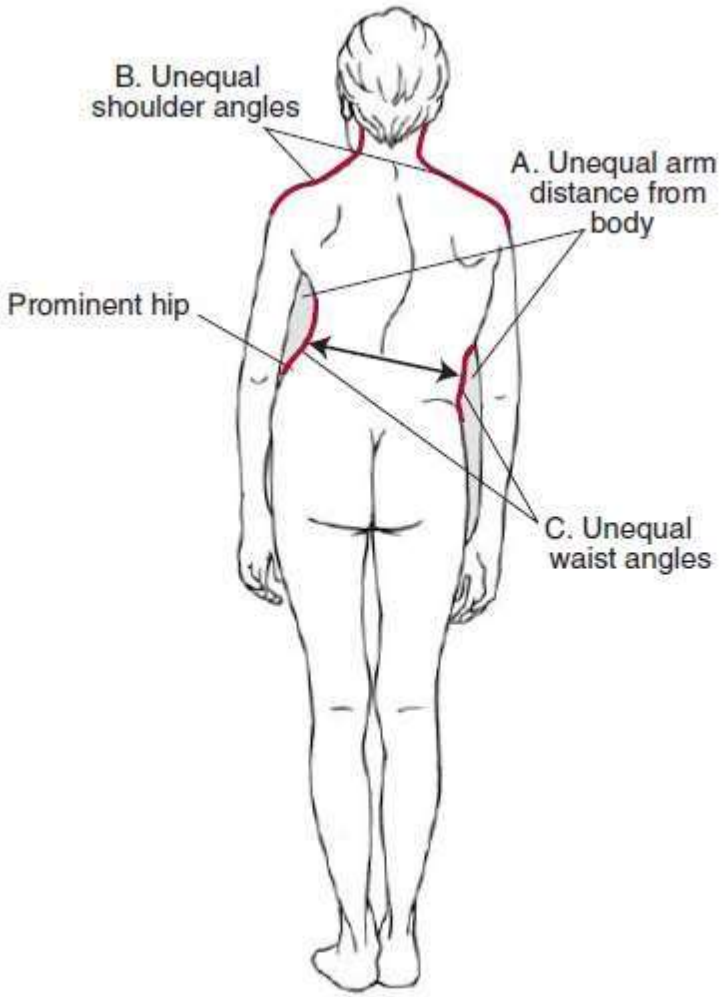
- Foot and toes
  - Pes planus (flat foot)
    - Rigid flat foot
    - Flexible flat foot
  - Pes Cavus
- Knee
  - Genu valgum
  - Genu varum
  - Squinting or cross-eyed patella (patella that face medially)
  - Grasshopper-eyes patella





Deviations from optimal alignment in the frontal plane

- Vertebral column
  - –Scoliosis
    - Two classifications
      - Functional
      - Structural



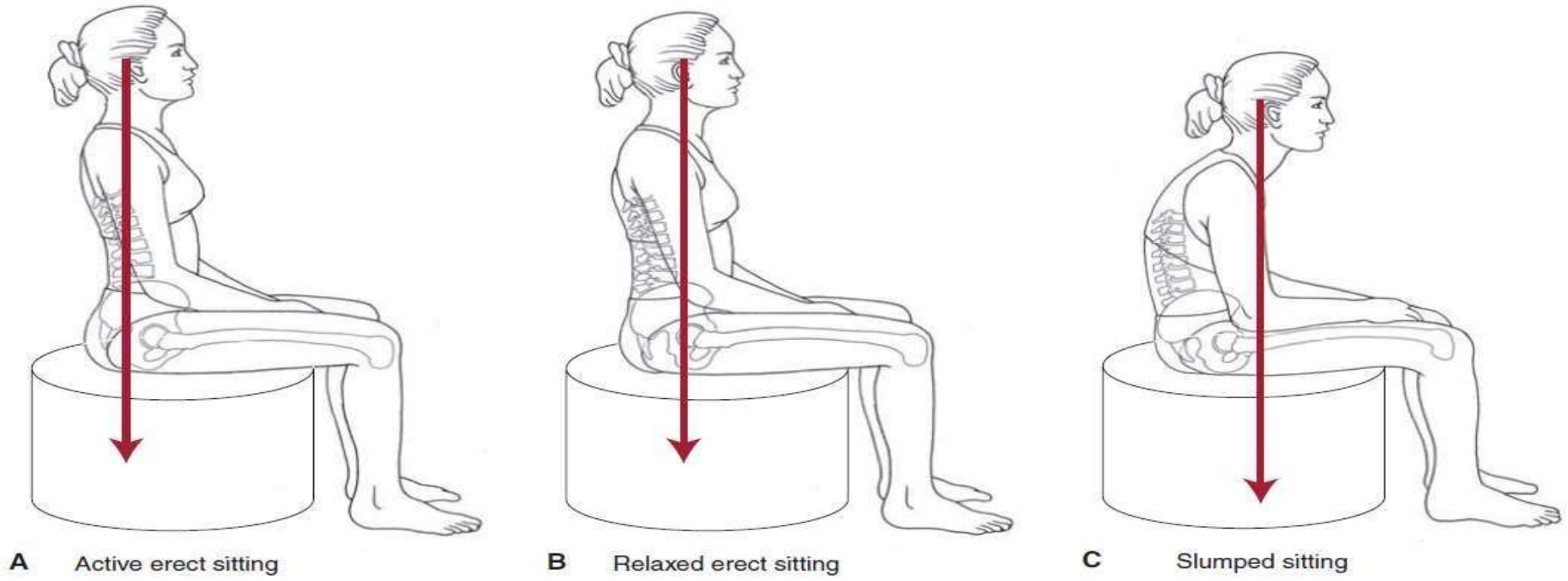
▲ **Figure 13–28** ■ A lateral curvature of the vertebral column that is convex to the right in the thoracic region and convex to the left in the lumbar region.

Analysis of Sitting Posture

- Goal: to attain a **stable alignment** of the body that can be maintained with the least expenditure of energy and the least stress on body structures
- Active erect sitting position:
  - an unsupported posture in which a person attempts to sit up as straight as possible

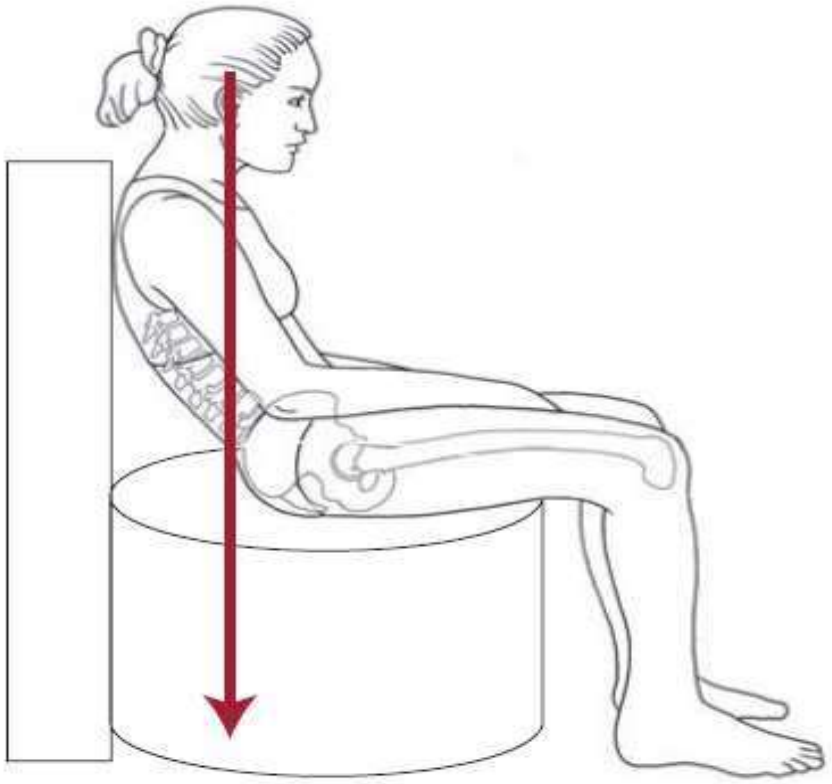
Analysis of sitting posture

- Muscle activity
- Interdiskal pressures



▲ **Figure 13-30** ■ A. In the active erect sitting position, the LoG is close to the axes of rotation of the head, neck, and trunk. B. In the relaxed erect sitting posture, the LoG still is relatively close to those axes of rotation. C. In the slumped position, the LoG is relatively distant from the axes of rotation of the head, neck, and trunk.

Analysis of sitting posture



Slouched sitting

▲ **Figure 13–31** ■ In the slouched sitting posture, the LoG is at a distance from the axes of rotation at the head, neck, and trunk, but the back of the chair is providing support in lieu of muscle support.

Analysis of sitting posture

- **Seat interface pressures:**
  - the pressure caused by contact forces between the person's body and the seat

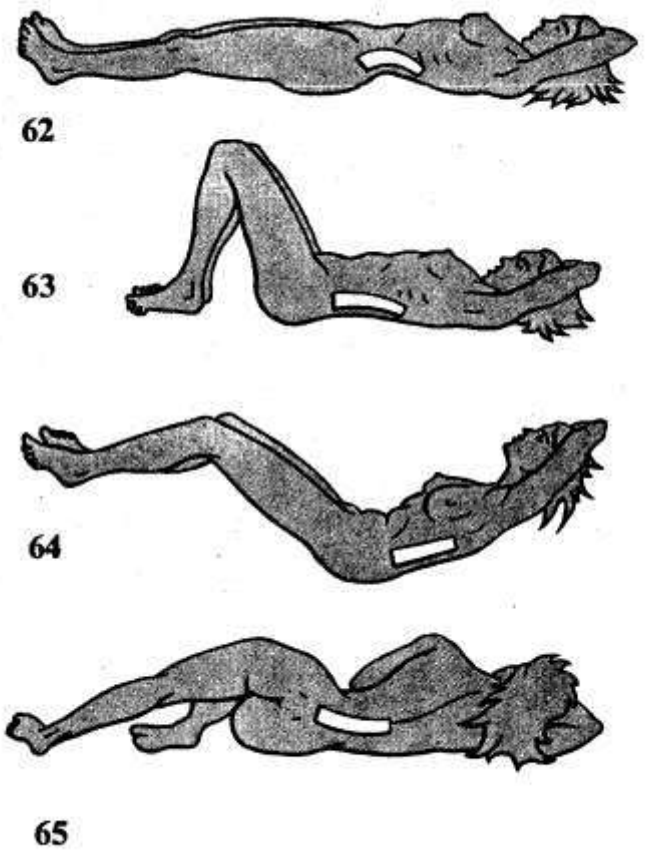
- Individuals with physical disabilities have significantly higher seat interface pressures than do people without such disabilities

Analysis of lying posture

- Interdiskal pressures
  - Are less in lying postures than in standing and sitting postures

Analysis of lying posture

- Elements
  - Firm mattress for support
  - Not too many pillows - Maybe none
  - Lying flat on back may decrease lordosis
  - Hook-lying may preserve lordosis
  - Side-lying may be more comfortable



Analysis of lying posture

- Surface interface pressures
  - –Uniform pressure distribution over the entire available surface is desirable to prevent sections of increased pressure over certain areas

Effects of age, pregnancy, occupation and recreation on posture

- Age
  - –Infants and children
  - –Elderly
- Pregnancy
- •Occupation and recreation
  - –“overuse injuries’

Summary

- What are the different synergies?
- In erect posture where will the line of gravity be?
- What are the different optimal postures?

Reference

- Levangie K, & Norkin C., 2005, Joint structure and function, a comprehensive analysis •Hamill J, & Knutzen K., 2003, Biomechanical basis of human movement