Pathological Gait

Kinesiology
RHS 341
Lecture **13**
Dr. Einas Al-Eisa

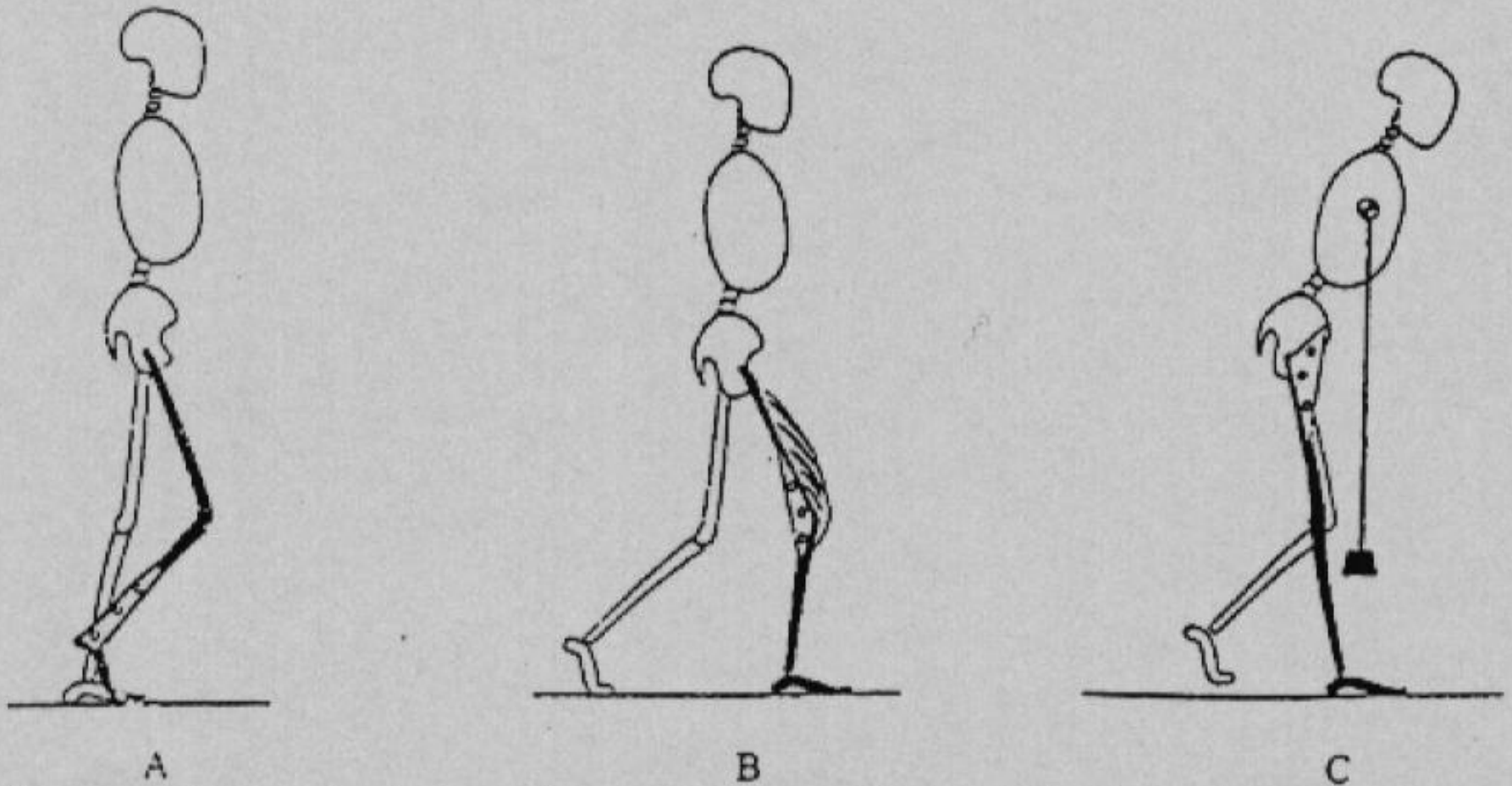
Causes

1. Deformity
2. Impaired motor control (spasticity)
3. Sensory loss
4. Pain
5. Muscle weakness

1. Deformity

Contracture is the most common cause of deformity, such as:

- **Plantar flexion contracture:**
  - In stance: blocks progression of the limb over the supporting foot
  - In swing: inhibits floor clearance (increased hip flexion is needed)



Examples for pathological gait due to deformity. (A) plantar flexion contracture, (B) knee flexion contracture, and (C) hip flexion contracture. Contracture is indicated by bolted plate.

1. Deformity

- **Knee flexion contracture:**
  - ➢Blocks progression during stance
  - ➢Increases the activity in the quadriceps in order to stabilize the knee

1. Deformity

- **Knee extension contracture:**

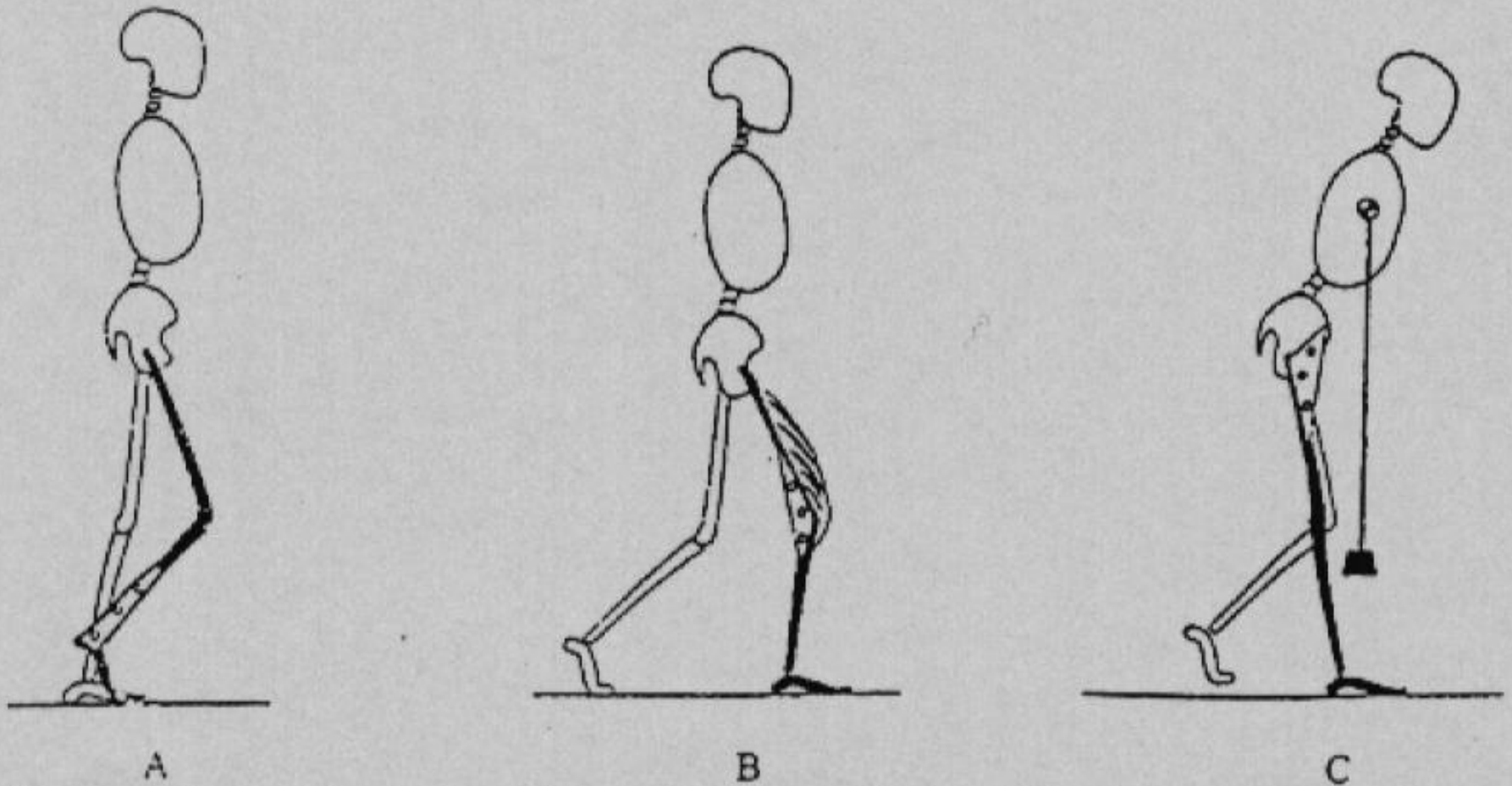
  - Increases the energy cost of walking due to the additional body maneuvers required for foot clearance

1. Deformity

- **Hip flexion contracture:**

  - To place the body's COG over the supporting foot, the trunk must lean forward

  - introduces strain on the back muscles and hip extensors



Examples for pathological gait due to deformity. (A) plantar flexion contracture, (B) knee flexion contracture, and (C) hip flexion contracture. Contracture is indicated by bolted plate.

2. Impaired motor control (spasticity)

- **Soleus and gastrocnemius spasticity:**

  ➢Lead to persistent ankle plantar flexion

2. Impaired motor control (spasticity)

- **Hamstring spasticity:**

  - leads to persistent knee flexion
  - limits the effectiveness of terminal swing
  - restricts thigh advancement in stance

2. Impaired motor control (spasticity)

- **Hip flexor spasticity:**

  - Restricts progression in mid and terminal stance

2. Impaired motor control (spasticity)

- **Sustained quadriceps action:**

  - Inhibits pre-swing preparation for limb advancement

3. Sensory loss

- Prevents the patient from knowing the position of the hip, knee, ankle, or foot

3. Sensory loss

- **Moderate** sensory loss causes ***slow* walking**
- **Greater** sensory loss may ***obstruct* walking** as it causes the patient to be unable to use his available motor control because he/she can not trust the motions that occurs

4. Pain

- Major causes of musculoskeletal pain are:
  - Excessive **tissue tension**
  - **Joint distension** related to trauma or arthritis

Pain in the limbs:

May be classified under 4 headings:

1. Joint pain
2. **Soft tissue pain**
3. Neurogenic pain
4. Orthopaedic causes (**fractures**, **dislocations**, tumors, infections)

4. Pain

- Physiological reactions to pain are:
  - **Deformity**
  - **Muscular weakness**

5. Muscle weakness

- When the patient's **muscle strength is insufficient** to meet the demands of walking

- Can be caused by **disuse muscular atrophy** or **neurological impairment**

Weakness of hip extensors (Gluteus maximus)

- **Normal function:**

  - During initial contact and loading response, the GRFV lies anterior to the hip joint creating flexion moment which is compensated by the action of the gluteus maximus of the supporting leg

Weakness of hip extensors (Gluteus maximus)

- **Effect of weakness on gait:**

  - Inability to counteract the flexion moment

  - Tendency for **excessive hip flexion** and **anterior pelvic tilt**

Weakness of hip extensors (Gluteus maximus)

- **Possible compensation:**

  - The patient will **lean the trunk backward** to shift the GRFV behind the axis of the hip joint and to prevent the trunk from falling forward (**gluteus maximus gait**)

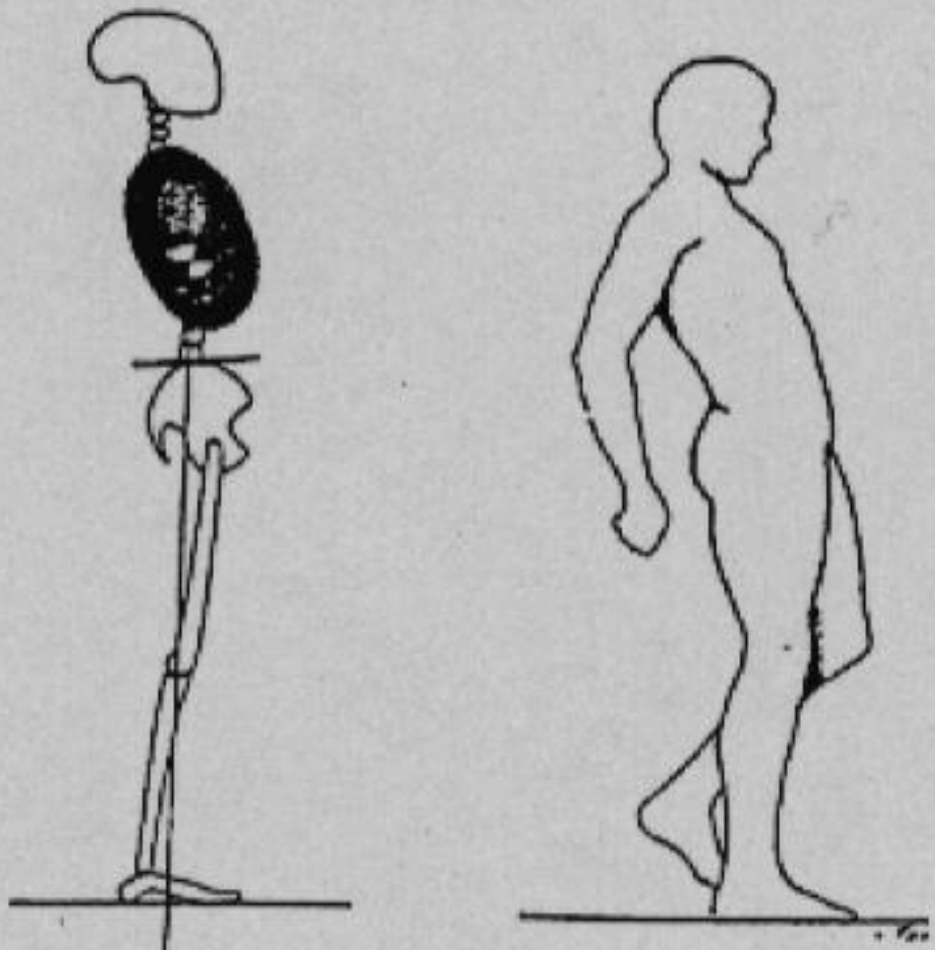
Weakness of hip extensors (Gluteus maximus)

- **Possible compensation:**

  - Note: the trunk will lean backward during the entire stride whether the weakness is unilateral or bilateral

Weakness of hip extensors (Gluteus maximus)

- **Long term effects of compensation:**
  - **Excessive lumbar lordosis**



Shifting the GRFV behind the hip joint to compensate for hip extensor muscle weakness.

Weakness of hip abductors (Gluteus medius & minimus)

- **Normal function:**

  - During single limb support, the GRFV lies medial to the hip joint creating adduction moment

Weakness of hip abductors (Gluteus medius & minimus)

- **Normal function:**

  - There is tendency of the pelvis and trunk to drop laterally to the opposite side (toward the swing limb) by the effect of the adduction moment

Weakness of hip abductors (Gluteus medius & minimus)

- **Normal function:**

  - Adduction moment is counterbalanced by the action of the abductor muscles on the stance limb to prevent the trunk and pelvis from dropping to the unsupported side

Weakness of hip abductors (Gluteus medius & minimus)

- **Effect of weakness on gait:**

  - Inability to counteract the adduction moment, so the pelvis will drop towards the swing side (positive **Trendlenburg sign**)

Weakness of hip abductors (Gluteus medius & minimus)

- **Possible compensation:**

  - If the weakness is **unilateral**: the patient will lean the trunk laterally toward the weak limb every time it contacts the ground and throughout the stance phase (**gluteus medius gait**)

Weakness of hip abductors (Gluteus medius & minimus)

- **Possible compensation:**

  - If the weakness is **bilateral**: (**waddling gait**)

Weakness of hip abductors (Gluteus medius & minimus)

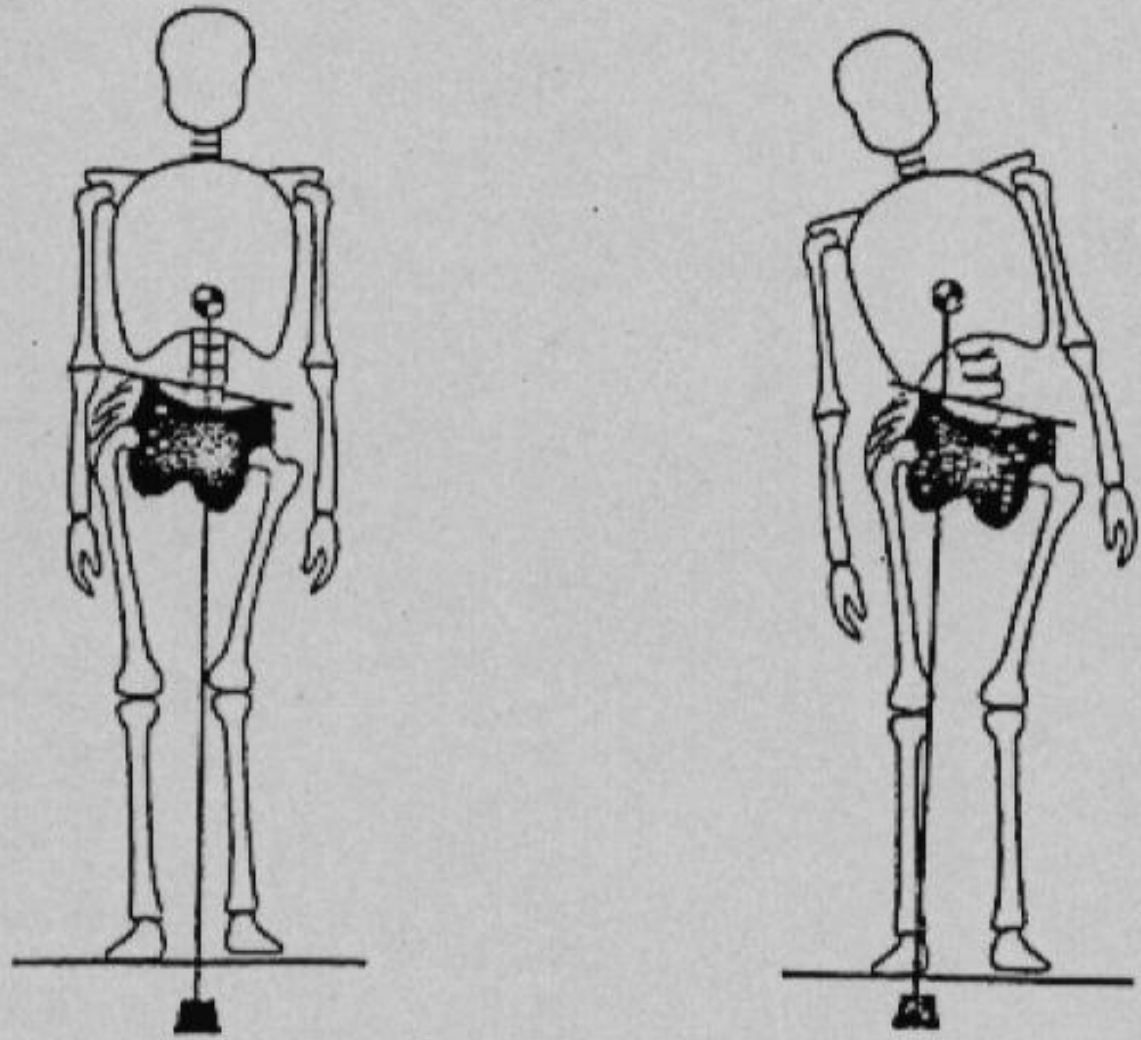
- **Possible compensation:**

  - Note: lateral leaning of the trunk shifts the GRFV to pass either through the hip joint (where no moment is created), or lateral to the hip joint (creating abduction moment to be compensated by the adductors)

Weakness of hip abductors (Gluteus medius & minimus)

- **Long term effects of compensation:**

  - Lateral spinal curve (**functional scoliosis**)



(A) (B)

Contralateral pelvic drop resulting from weak ipsilateral hip abductors. (A) the body COG is displaced away from stance limb, (B) compensating trunk lean and COG moves toward stance limb.

Weakness of knee extensors (Quadriceps)

- **Normal function:**

  - During loading responses, the GRFV lies posterior to the knee joint creating flexion moment which is compensated by the eccentric action of the quadriceps muscle

Weakness of knee extensors (Quadriceps)

- **Effect of weakness on gait:**

  - Inability to counteract the flexion moment

  - Tendency for excessive knee flexion during loading response and instability at heel strike

Weakness of knee extensors (Quadriceps)

- **Possible compensation:**

  - The hip extensors (gluteus maximus) and plantar flexors (soleus) will tend to pull the femur & tibia posteriorly resulting in knee extension

Weakness of knee extensors (Quadriceps)

- **Possible compensation:**

  - The trunk will lean forward to shift the GRFV anterior to the knee joint creating an extension moment and **placing the knee in hyperextension** (which eliminates the need for the quadriceps action)

Weakness of knee extensors (Quadriceps)

- **Possible compensation:**

  - If both the quadriceps and gluteus maximus are paralyzed, the patient may compensate by **pushing the femur posteriorly with his hand** at initial contact and loading response (to prevent hip flexion and put the knee into extension)

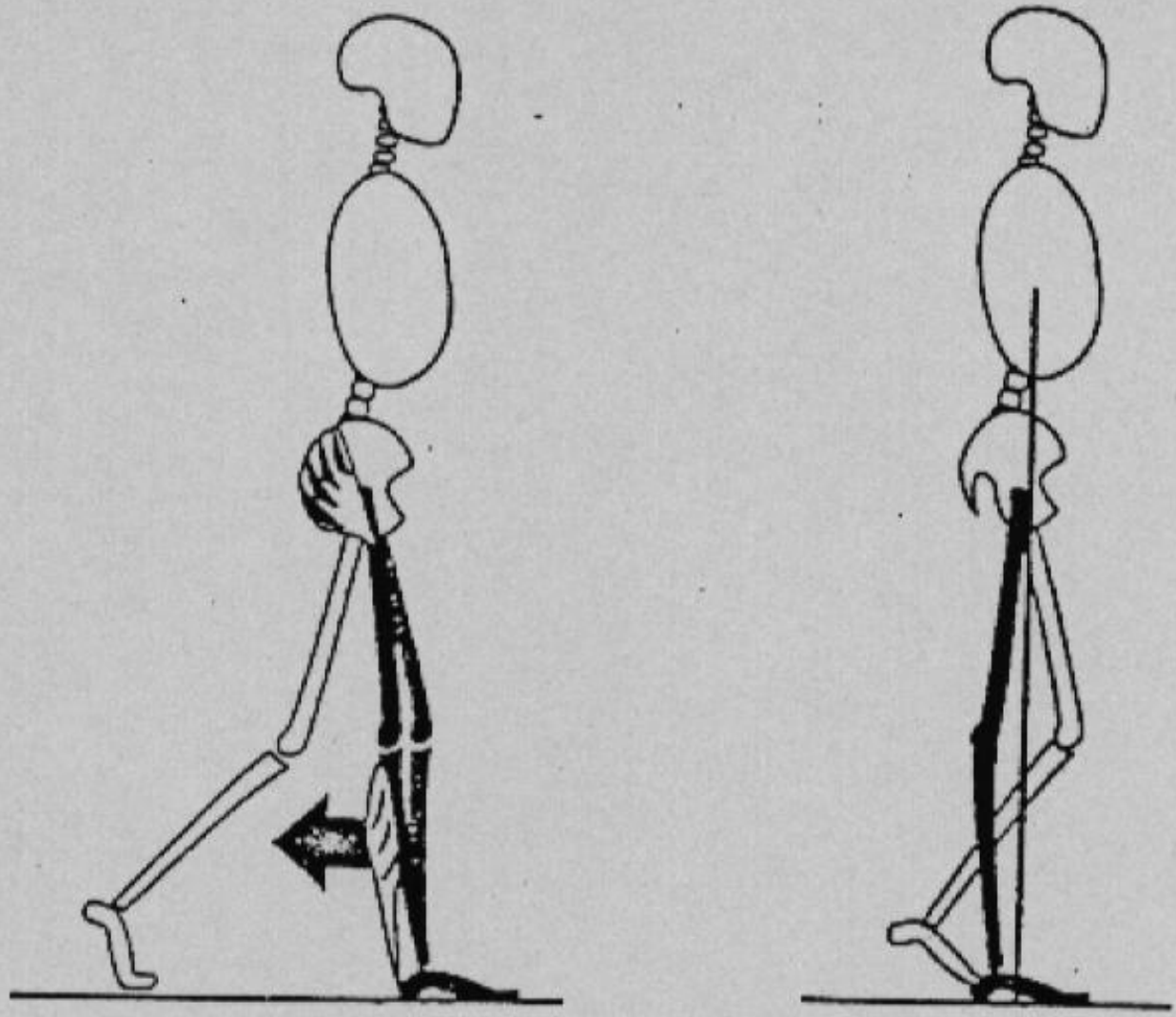
Weakness of knee extensors (Quadriceps)

- **Possible compensation:**

  - The patient may **turn the limb outward** to lock the knee joint in extension (eliminating the need for quadriceps activity)

Weakness of knee extensors (Quadriceps)

- **Long term effects of compensation:**
  - Disabling fatigue
  - Degeneration of the ligaments supporting the hyper-extended knee (due to chronic strain)



(A) (B)

Substitution for weak quadriceps. (A) is the action of the soleus and gluteus maximus to retract the tibia and the femur. (B) is the shifting of the GRFV anterior to the knee joint.

Weakness of dorsiflexors (Tibialis anterior)

- **Normal function:**

  - During initial contact and loading response, the GRFV lies posterior to the ankle joint creating plantar flexion moment which is compensated by the action of the tibialis anterior

Weakness of dorsiflexors (Tibialis anterior)

- **Normal function:**

  - Note: the action of the tibialis anterior is concentric during initial contact, then the action changes to eccentric during loading response (to prevent **foot slap**)

Weakness of dorsiflexors (Tibialis anterior)

- **Effect of weakness on gait:**

  - Inability to counteract the plantar flexion moment

  - **Excessive plantar flexion**

Weakness of dorsiflexors (Tibialis anterior)

- **Effect of weakness on gait:**

  - The entire foot and toes would strike the floor at initial contact (lack of normal heel strike)

  - **Toe drag** during swing phase

Weakness of dorsiflexors (Tibialis anterior)

- **Possible compensation:**

  - Increased hip and knee flexion to lift the limb and foot in swing phase (**high steppage gait**)

  - Or: **hip hiking** of the affected side

Weakness of dorsiflexors (Tibialis anterior)

- **Possible compensation:**

  - If knee flexion is impaired: the limb can be lifted by **cricumduction of the leg**

Weakness of dorsiflexors (Tibialis anterior)

- **Long term effects of compensation:**

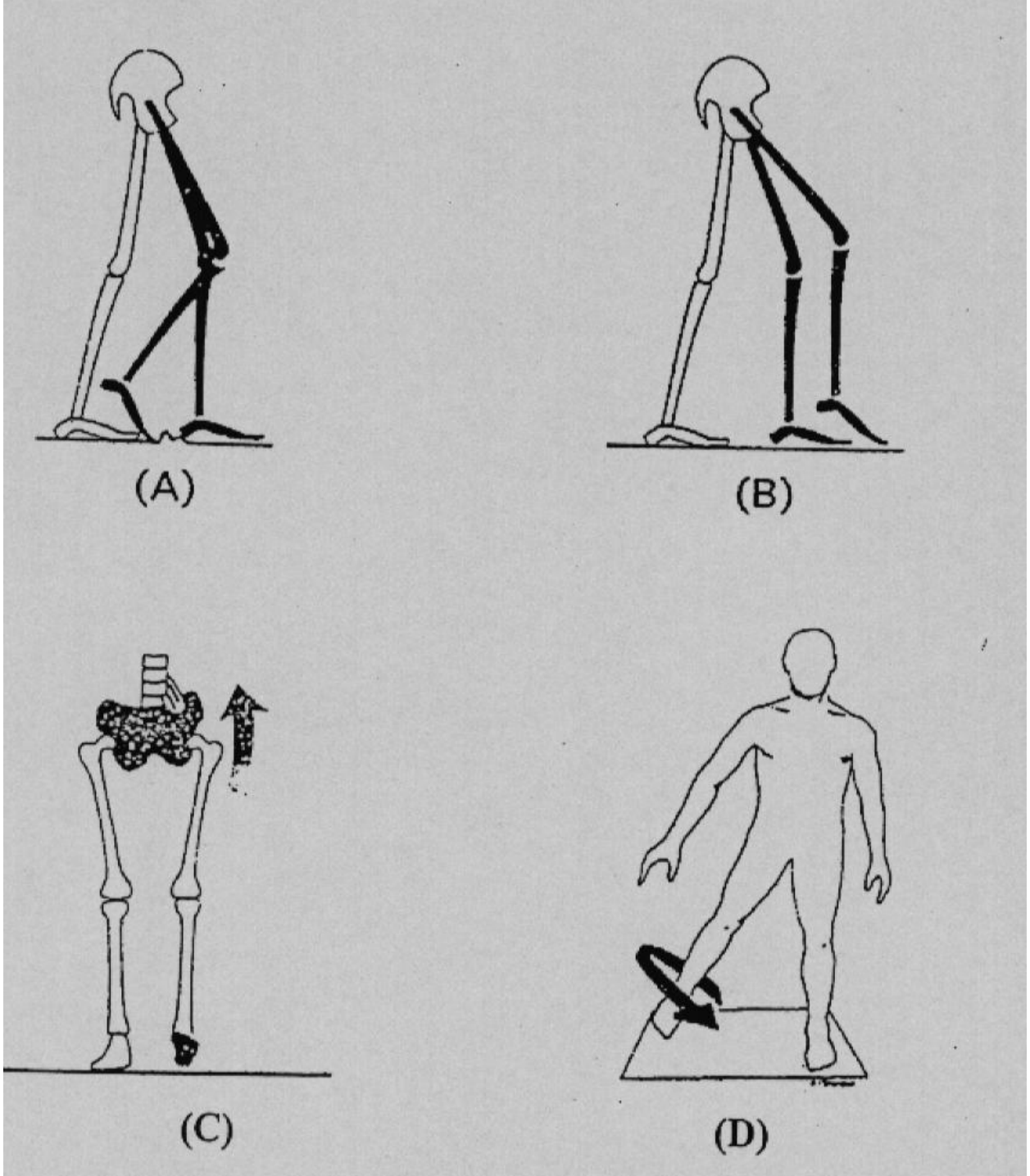
  - Easy fatigue due to increased energy expenditure as a result of the compensation

A: toe drag

B: high steppage gait

C: hip hiking

D: circumduction



Weakness of Calf Muscles

- **Normal function:**

  - During mid-stance, terminal stance and pre-swing, the GRFV lies anterior to the ankle joint creating dorsiflexion moment which is compensated by the action of the plantar flexors

Weakness of Calf Muscles

- **Normal function:**

  - Note: the calf muscles contract <u>eccentrically</u> 1st to oppose the dorsiflexion moment and control tibial advance, then contract <u>concentrically</u> to plantar flex the ankle in the later part of stance phase

Weakness of Calf Muscles

- **Effect of weakness on gait:**

  - Inability to counteract the dorsiflexion moment

Weakness of Calf Muscles

- **Effect of weakness on gait:**

  - **Excessive ankle dorsiflexion** and uncontrolled tibial advancement leading to **loss of tibial stability** during the weight bearing period (at the onset of single limb support)

Weakness of Calf Muscles

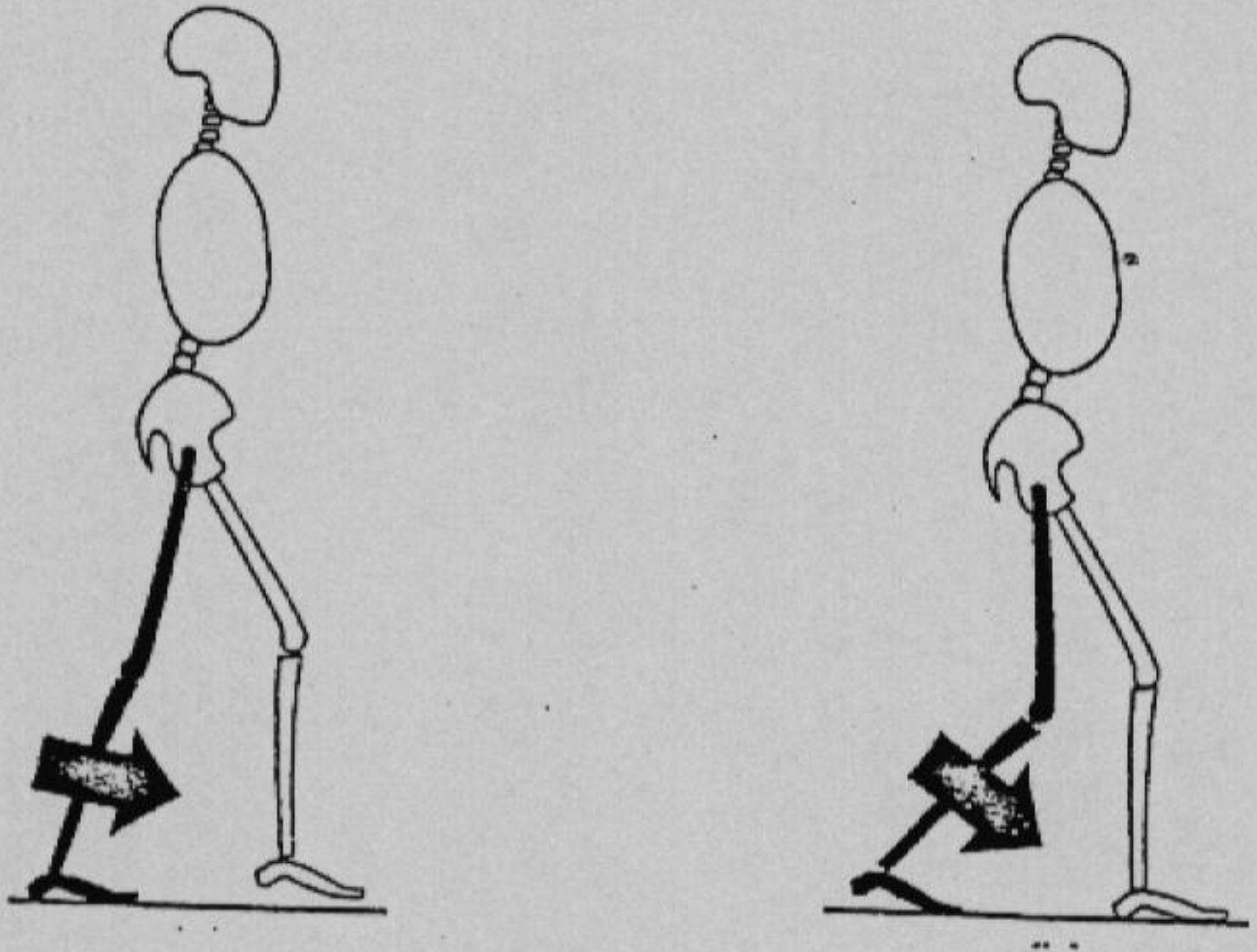
- **Possible compensation:**
  - ➢ Increased demand on quadriceps to counteract tibial instability
  - ➢ Terminal stance knee extension is lost and replaced with flexion

Weakness of Calf Muscles

- **Possible compensation:**

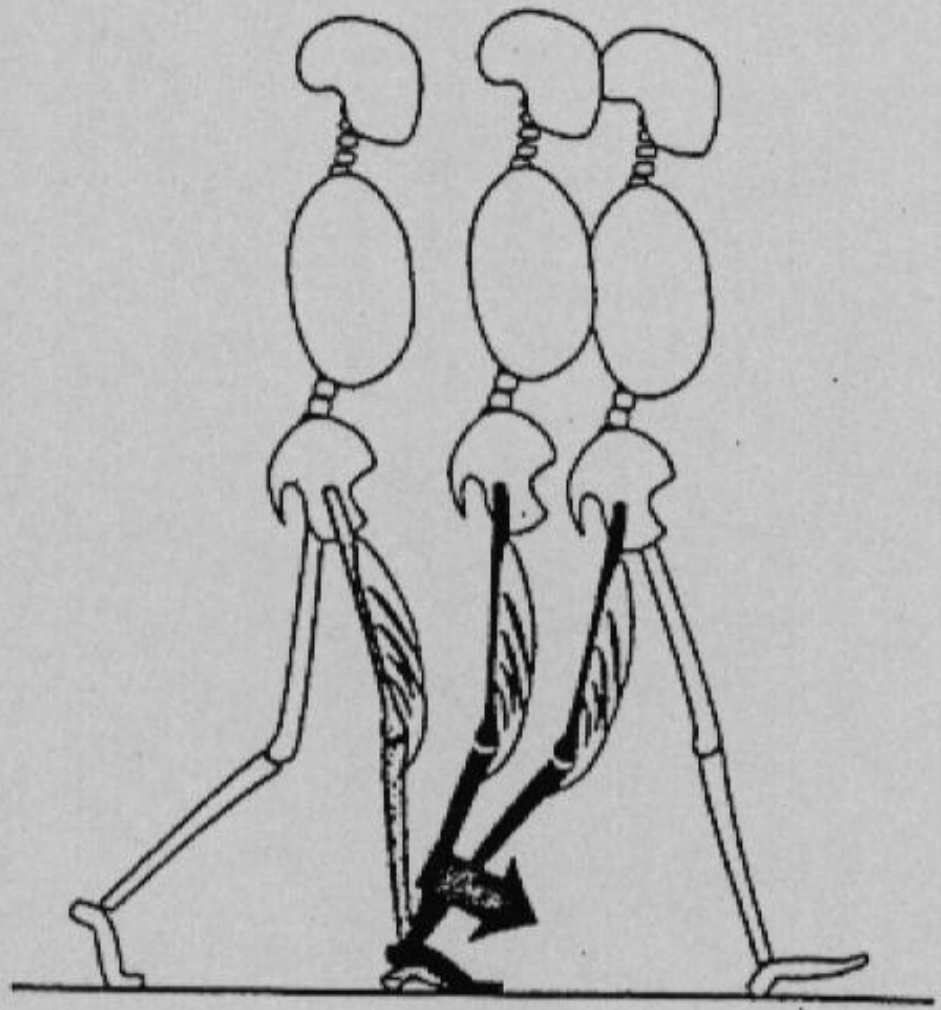
  - **Delayed heel rise** (prolonged heel contact) during stance phase (terminal stance and pre-swing)

  - Shorter steps and slower walking speed



(A) (B)

Excessive ankle dorsiflexion is represented by (A) prolonged heel contact and (B) excessive knee flexion.



(C)

Action of quadriceps muscle to counteract tibial instability leading to sustained knee flexion.

Correction of gait

- Exercise program geared for correction of, or compensation for, the disability or weakness:

  - **Strengthening & mobilizing** exercises
  - **Balance** training
  - Encouragement of **rhythmic rotatory trunk movements**

Correction of gait

- The patient must gain the **knowledge**, the **image** and the **feeling** of a correct posture and walking pattern

- The patient should stand upright looking straight ahead and not down at his feet (using a mirror)

Aids to walking

- May be temporary or permanent

- The choice depends on the patient's disability, general condition, and age:
  - Adjustable parallel bars
  - Sticks (canes)
  - Crutches

Crutches gait

1. **Four-point alternate crutch gait**

- Crutch-leg sequence:
  - Right crutch
  - Left leg
  - Left crutch
  - Right leg

- Safe, but slow gait

Crutches gait

2. Two-point alternate crutch gait

- Crutch-leg sequence:
  - Right crutch and left leg together
  - Left crutch and right leg together

- Faster than the four-point gait, and demands greater balance

Crutches gait

3. Three-point crutch gait

- Crutch-leg sequence:
  - Both crutches and the weaker leg
  - The stronger leg

- Used when one limb is unable to take any weight or only partial weight

Crutches gait

4. Swing-to crutch gait

- Crutch-body sequence:
  - Both crutches are lifted and placed on the ground in front of the body
  - The body swings forward to the crutches

Crutches gait

5. Swing-through crutch gait

- Crutch-body sequence:
  - Both crutches are lifted and placed on the ground in front of the body
  - The body swings through past the crutches, so the feet are ahead of the crutches