POSTURE

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OPTIMAL POSTURE

- In an optimal standing posture, the LoG is close to, but not through, most joint axes.
- Therefore, the external gravitational moments are relatively small and are balanced by internal moments generated by **passive capsular** and **ligamentous tension, passive muscle tension (stiffness),** and **a small but continuous amount of muscle activity.**
- The postural control system automatically activates the appropriate muscles to keep the body's CoG over the base of support.

ANALYSIS OF STANDING POSTURE: VIEWED FROM THE SIDE

- Observational analysis of posture involves locating body segments in relation to the LoG, which is represented by a **plumb line** (a line with a weight on one end).
- The line is dropped from the ceiling and can be used to assess a person’s posture from either the lateral aspect or from the anterior or posterior aspect.
- In an anterior or posterior analysis, the LoG should bisect the body into two symmetrical halves.

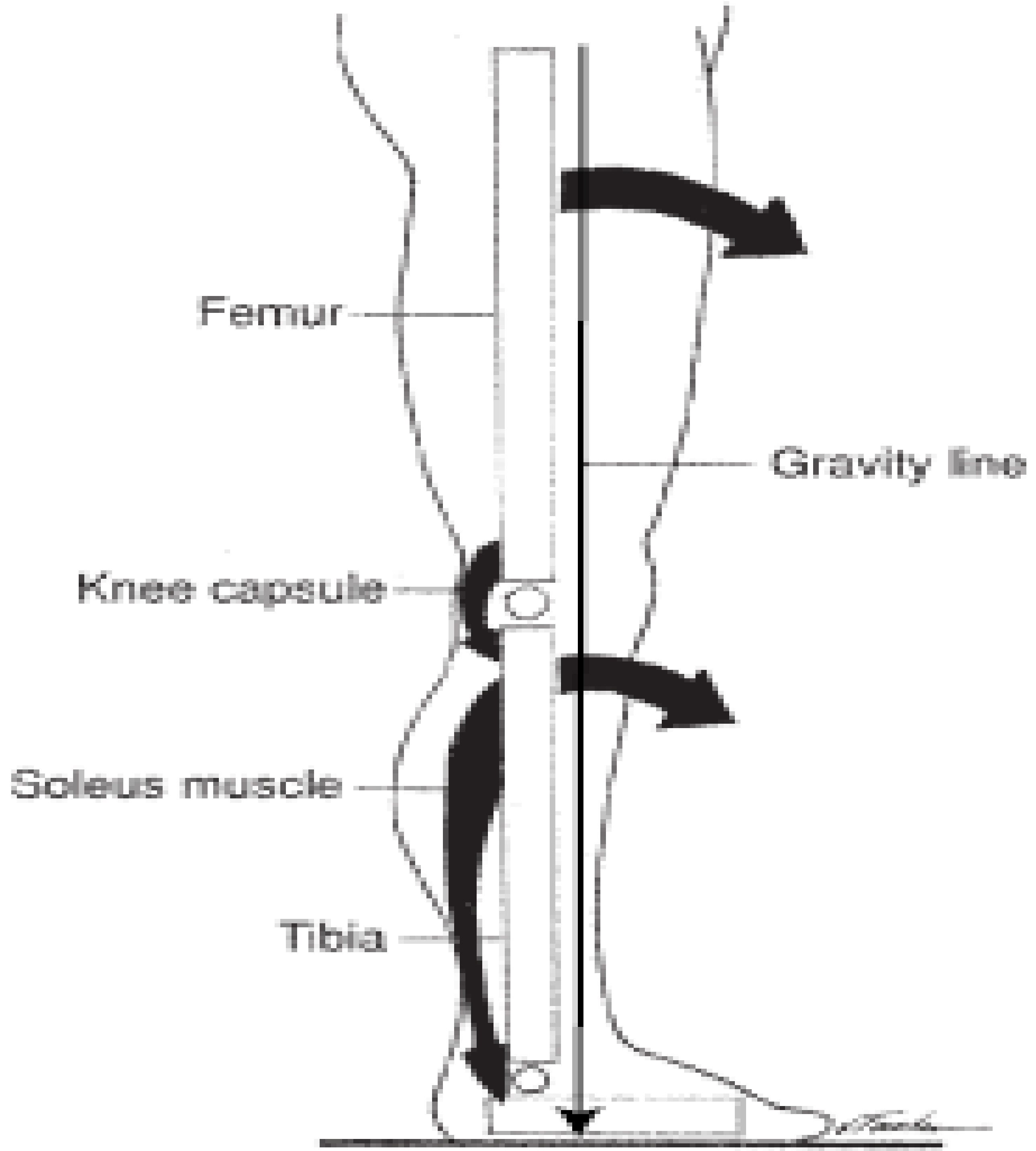
ALIGNMENT AND ANALYSIS: LATERAL VIEW

ANKLE:

- In the optimal erect posture, the ankle joint is in the neutral position, or midway between dorsiflexion and plantarflexion.
- The LoG passes slightly anterior to the lateral malleolus and, therefore, anterior to the ankle joint axis.
- The anterior position of the LoG in relation to the ankle joint axis creates an external dorsiflexion moment that must be opposed by an internal plantarflexion moment to prevent forward motion of the tibia.

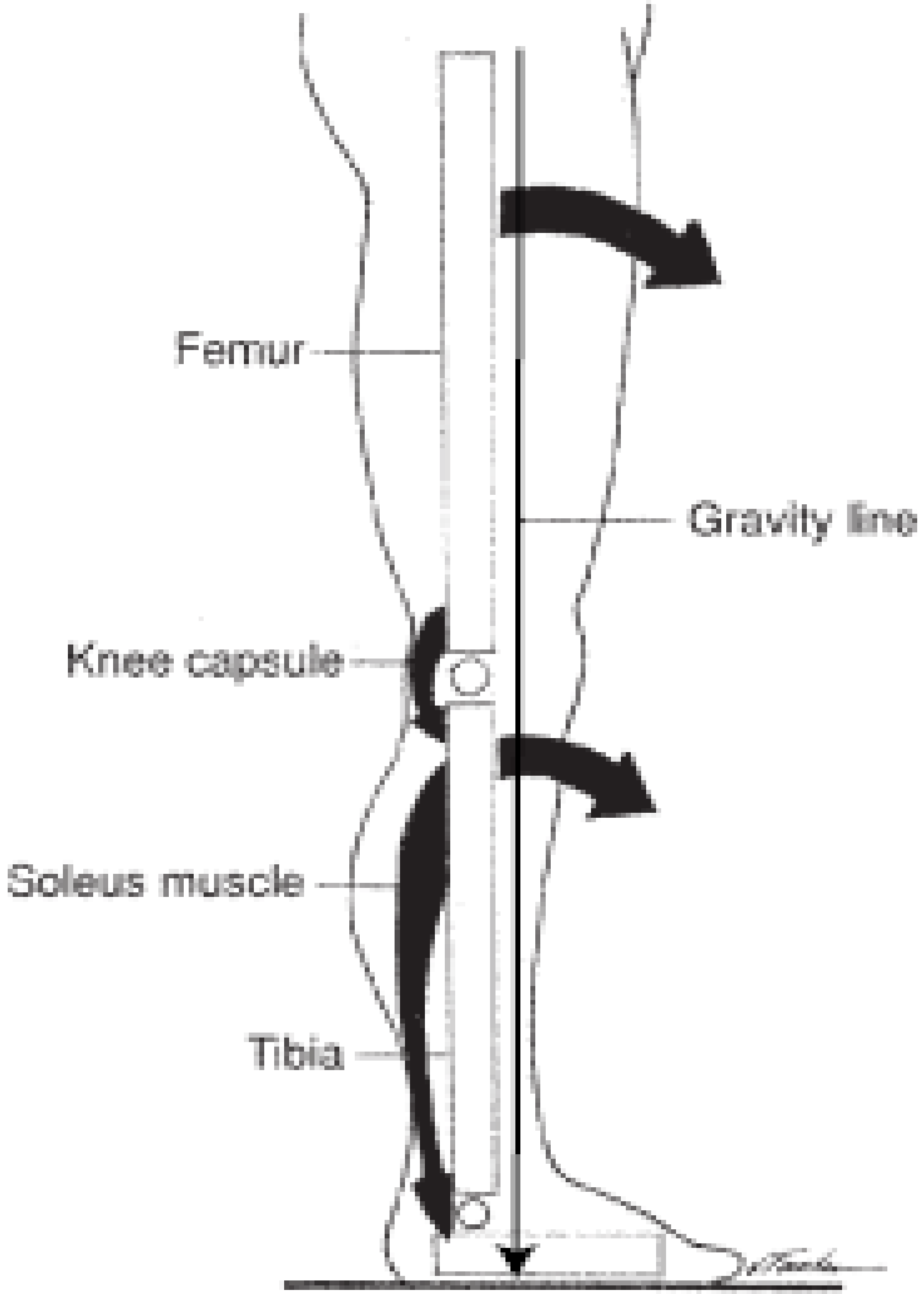
- In the neutral ankle position, there are no ligamentous checks capable of counterbalancing the external dorsiflexion moment; therefore, activation of the plantarflexors creates the internal plantarflexion moment that is necessary to prevent forward motion of the tibia.
- The soleus muscles contract and exert a posterior pull on the tibia and in this way is able to oppose the dorsiflexion moment.

- Electromyographic studies have demonstrated that soleus and gastrocnemius activity is fairly continuous in normal subjects during erect standing.



KNEE:

- In optimal posture, the knee joint is in full extension, and the LoG passes anterior to the midline of the knee and posterior to the patella.
- This places the LoG just anterior to the knee joint axis.
- The anterior location of the gravitational line in relation to the knee joint axis creates an **external extension moment** that tends to keep the knees extended.

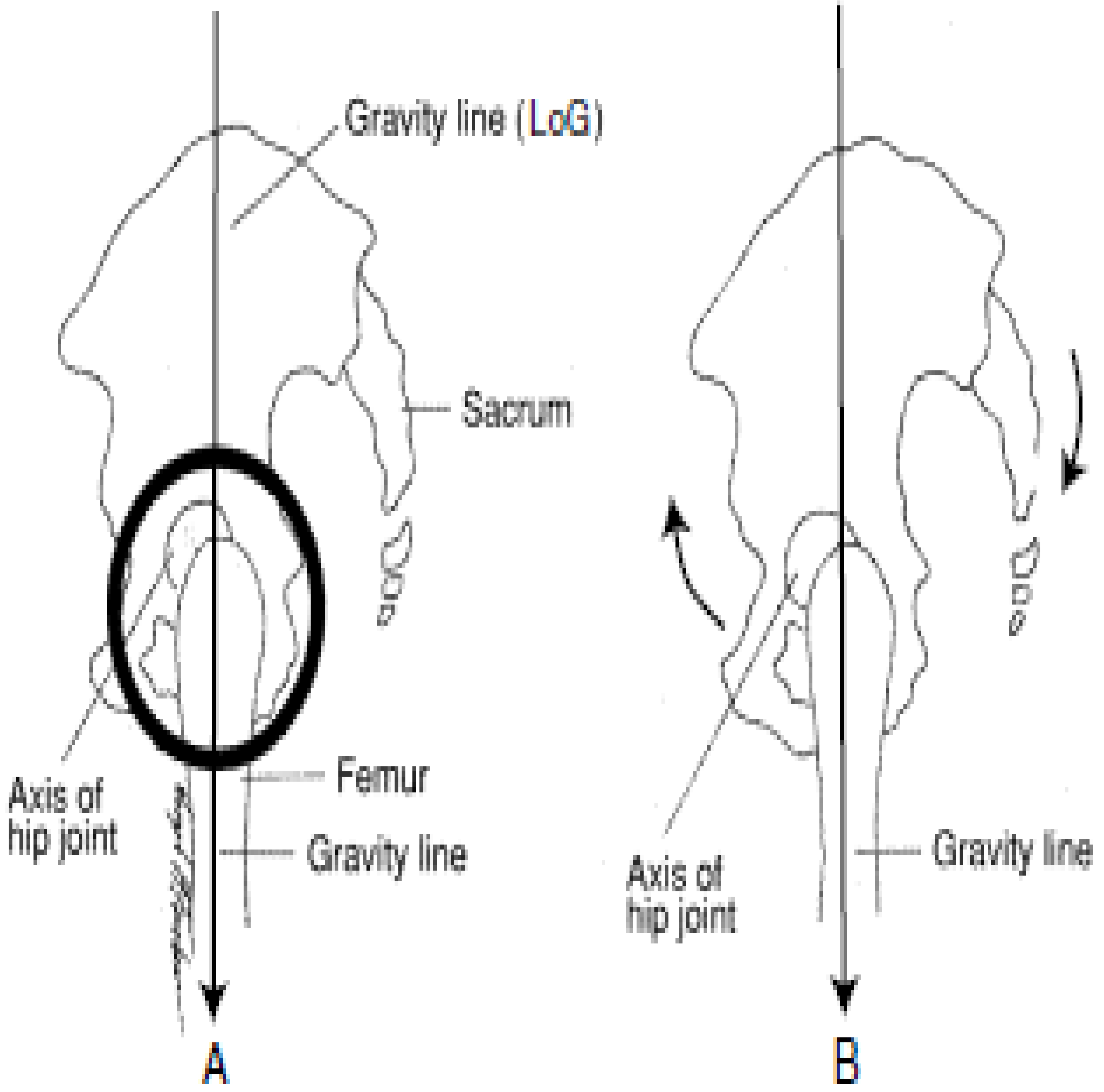


- The counterbalancing **internal flexion moment** created by passive tension in the posterior joint capsule and associated ligaments is usually sufficient to balance the gravitational moment and prevent knee hyperextension.
- However, a small amount of activity has been identified in the hamstrings.

HIP AND PELVIS

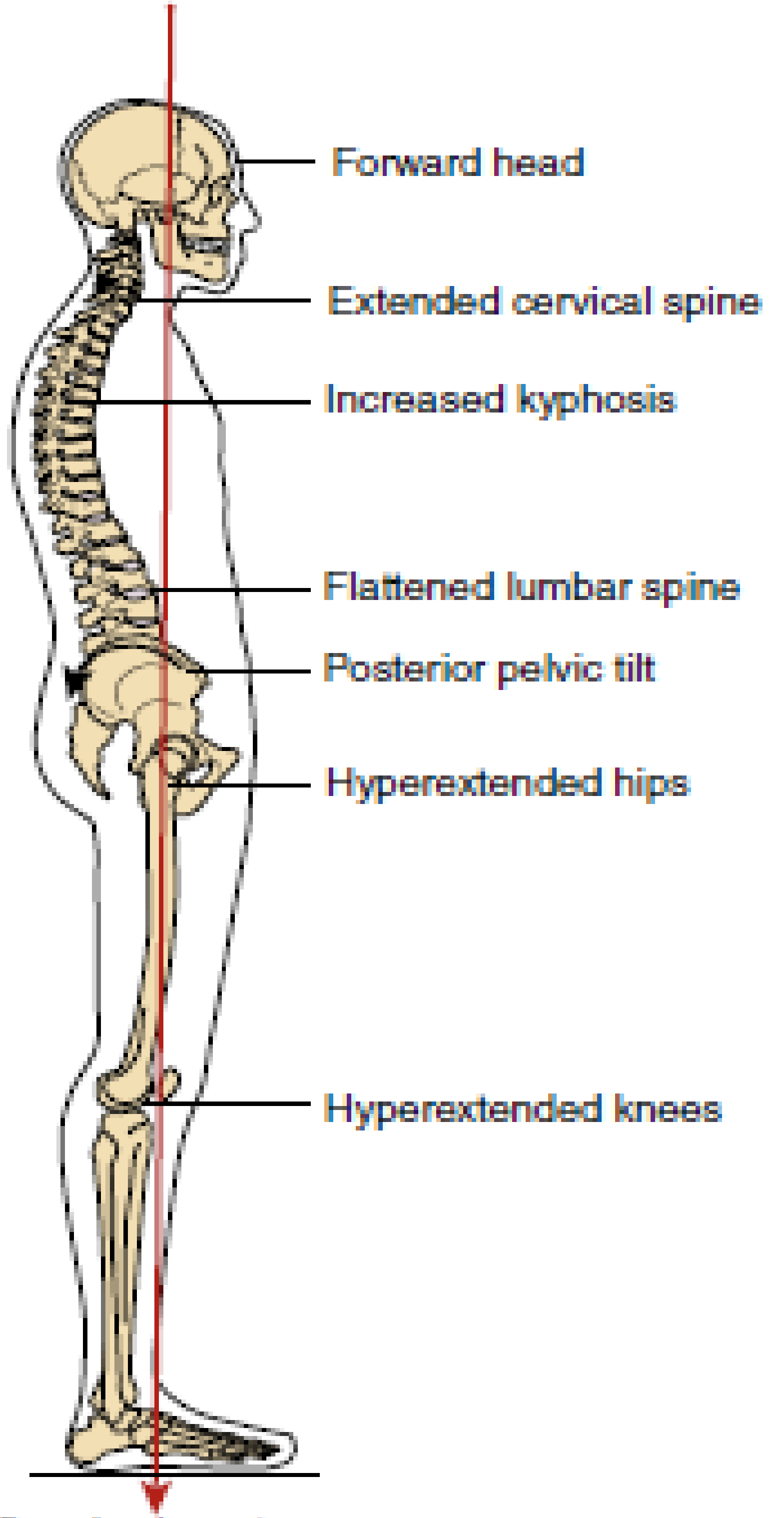
- In optimal posture, the hip is in a neutral position and the pelvis is level, with no anterior or posterior tilt.
- In a level pelvis position, lines connecting the symphysis pubis and the anterior superior iliac spines (ASISs) are vertical, and the lines connecting the anterior superior iliac spines and posterior superior iliac spines (PSISs) are horizontal.

- In this optimal position, the line of gravity passes slightly posterior to the axis of the hip joint, through the greater trochanter.
- The posterior location of the gravitational line in relation to the hip joint axis creates an external extension moment at the hip that tends to rotate the pelvis (proximal segment) posteriorly on the femoral heads.



- Electromyographic studies have shown activity of the iliopsoas muscle during standing, and it is possible that the iliopsoas is acting to create an internal flexion moment at the hip to prevent hip hyperextension.
- However, during postural sway, the LoG may pass anterior to the hip joint axis, and contraction of the hip extensors may be required.

- In the swayback standing posture, the LoG drops farther behind the hip joint axes than in the optimal posture.
- The pelvis is rotated posteriorly; the lumbar spine is flattened; the trunk is displaced posteriorly with an increased kyphosis; the head is forward; and the knees are hyperextended.

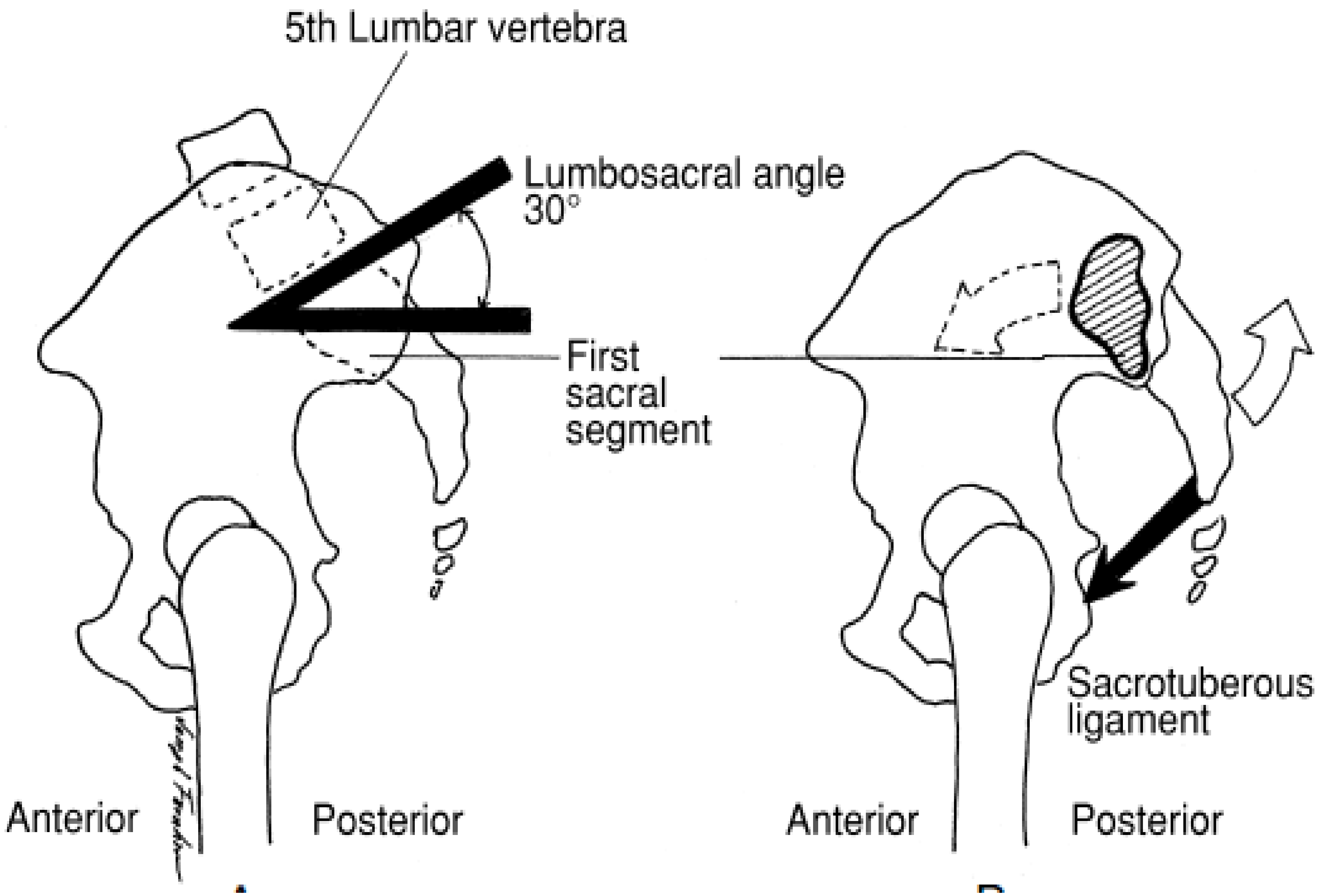


Swayback posture

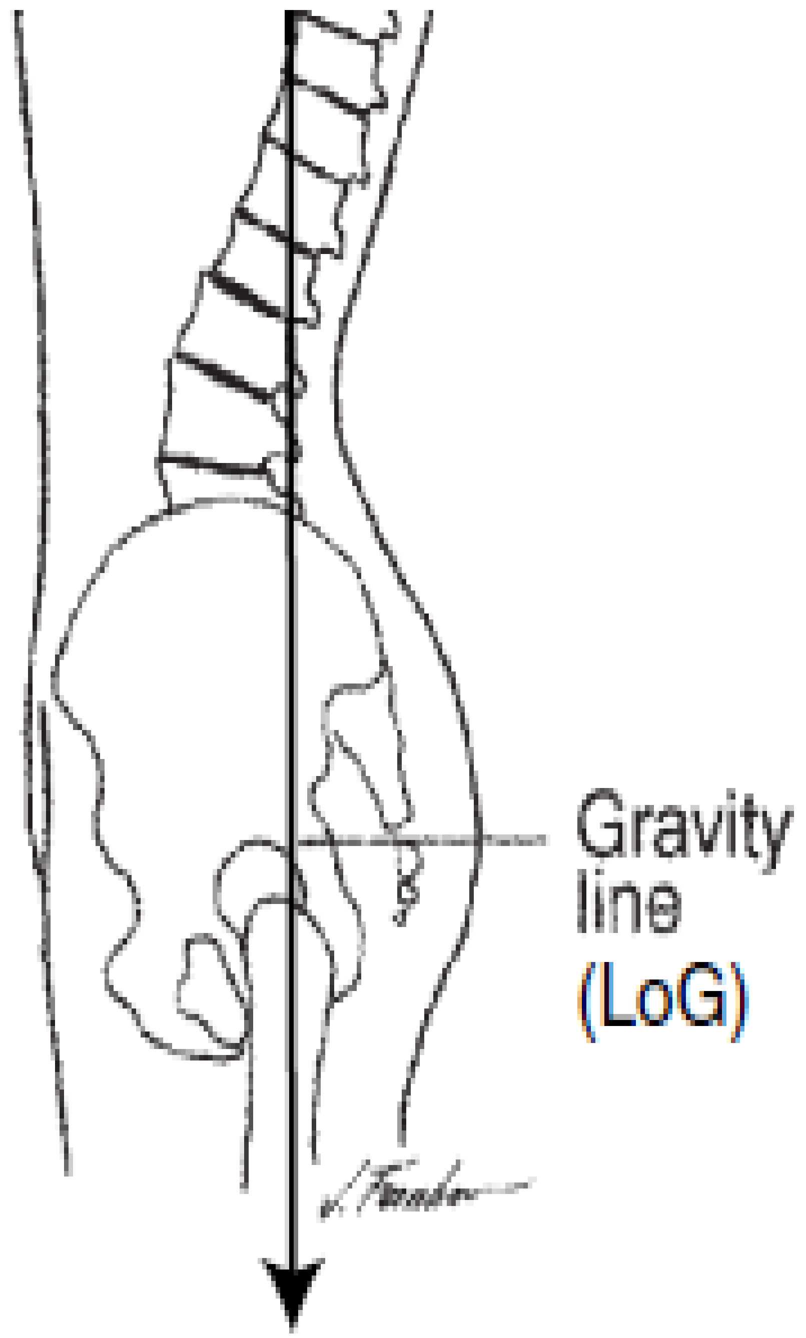
- The swayback posture does not require any muscle activity at the hip but causes an increase in the tension stresses on the anterior hip ligaments, which could lead to adaptive lengthening of these ligaments if the posture becomes habitual.
- Also, because of the diminished demand for hip extensor activity, the gluteal muscles may be weakened by disuse atrophy if the swayback posture is adopted habitually.

LUMBOSACRAL AND SACROILIAC JOINTS

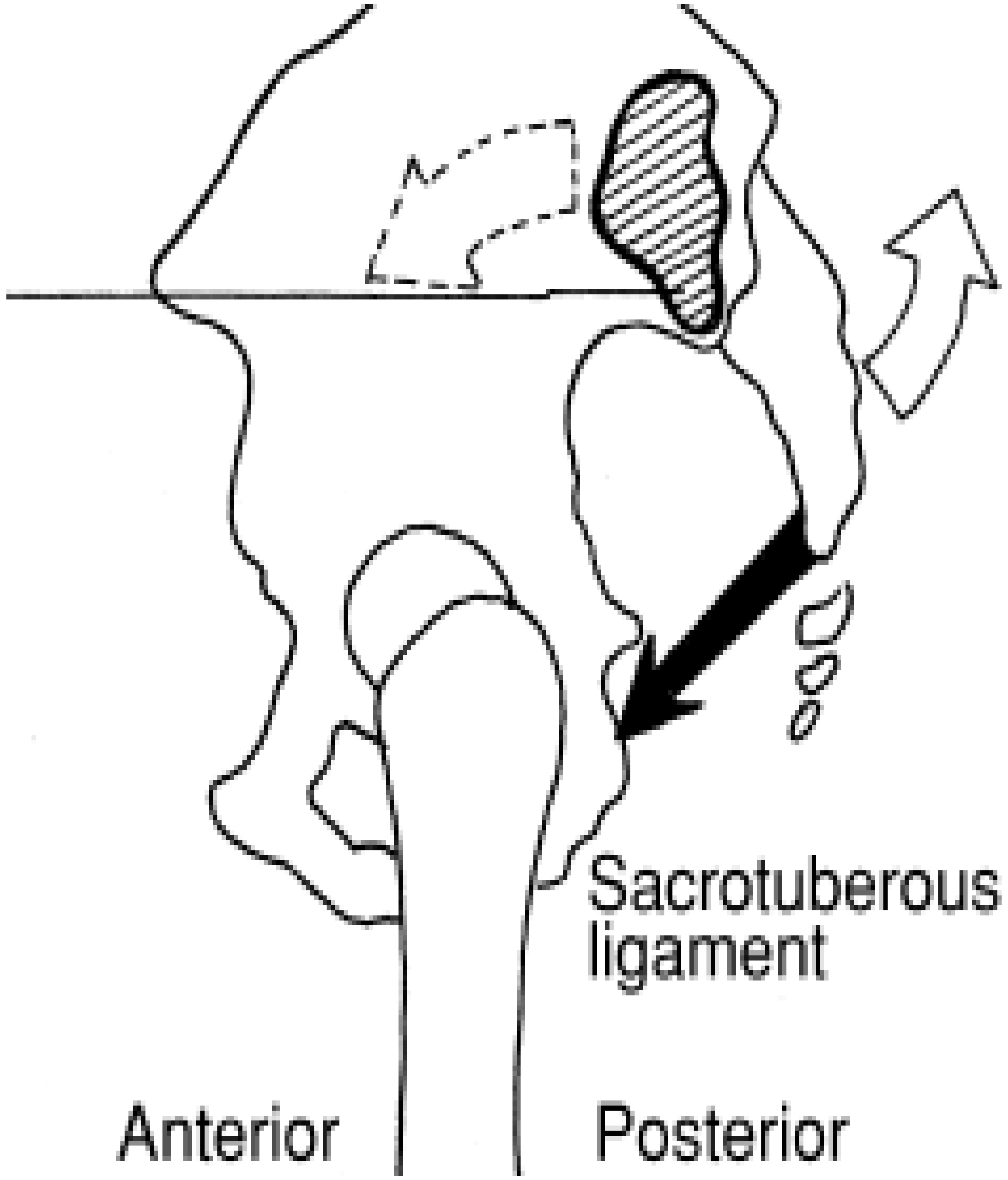
- The average lumbosacral angle measured between the bottom of the L5 vertebra and the top of the sacrum (S1) is about 30° but can vary between 6° and 30°.
- Anterior tilting of the sacrum increases the lumbosacral angle and results in an increase in the shearing stress at the lumbosacral joint and may result in an increase in the anterior lumbar convexity in standing


5th Lumbar vertebra
Lumbosacral angle 30°
First sacral segment
Anterior
Posterior
Anterior
Posterior
Sacrotuberous ligament

- In the optimal posture, the LoG passes through the body of the fifth lumbar vertebra and close to the axis of rotation of the lumbosacral joint.
- Gravity therefore creates a very slight extension moment at L5 to S1 that tends to slide L5 and the entire lumbar spine down and forward on S1.



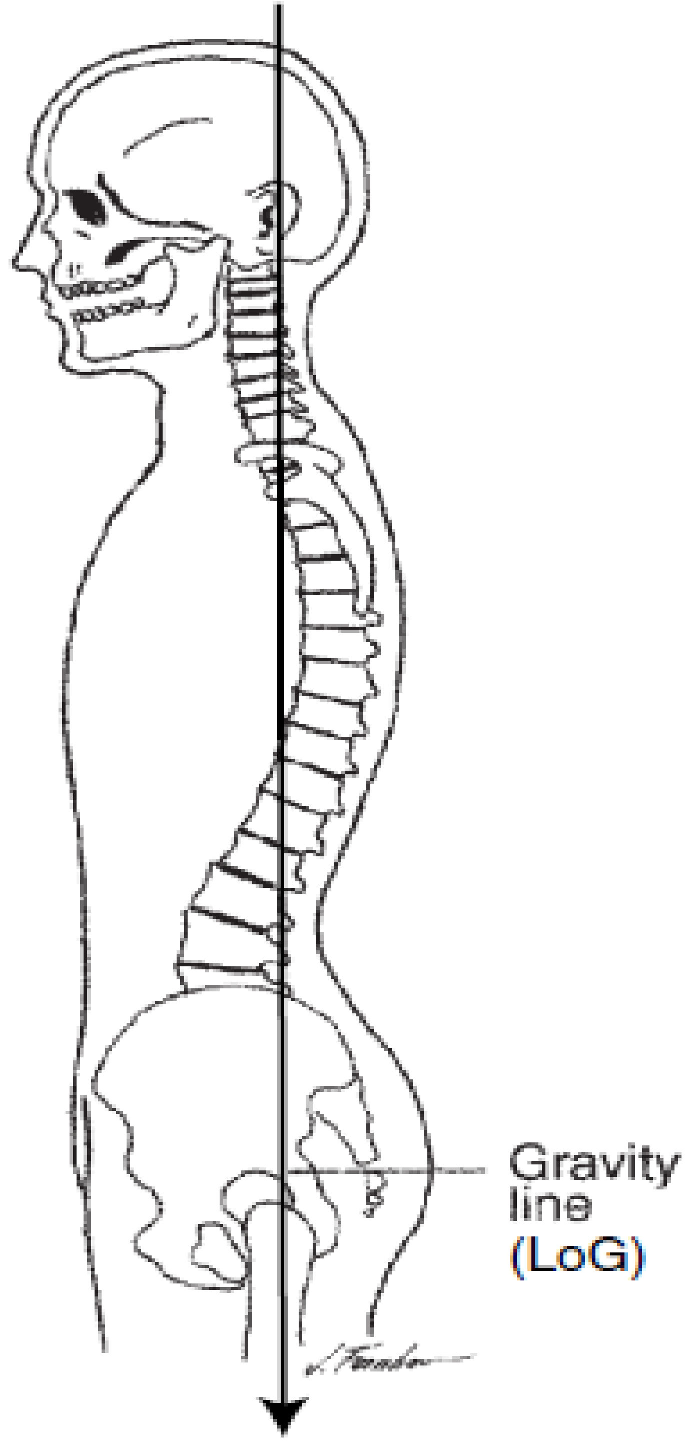
- This motion is opposed primarily by the anterior longitudinal ligament and the iliolumbar ligaments. Bony resistance is provided by the locking of the lumbosacral zygapophyseal joints.
- When the sacrum is in the optimal position, the LoG passes slightly anterior to the sacroiliac joints.



- The external gravitational moment that is created at 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.
- Passive tension in the sacrospinous and sacrotuberous ligaments provides the internal moment that counterbalances the gravitational torque by preventing upward tilting of the lower end of the sacrum.

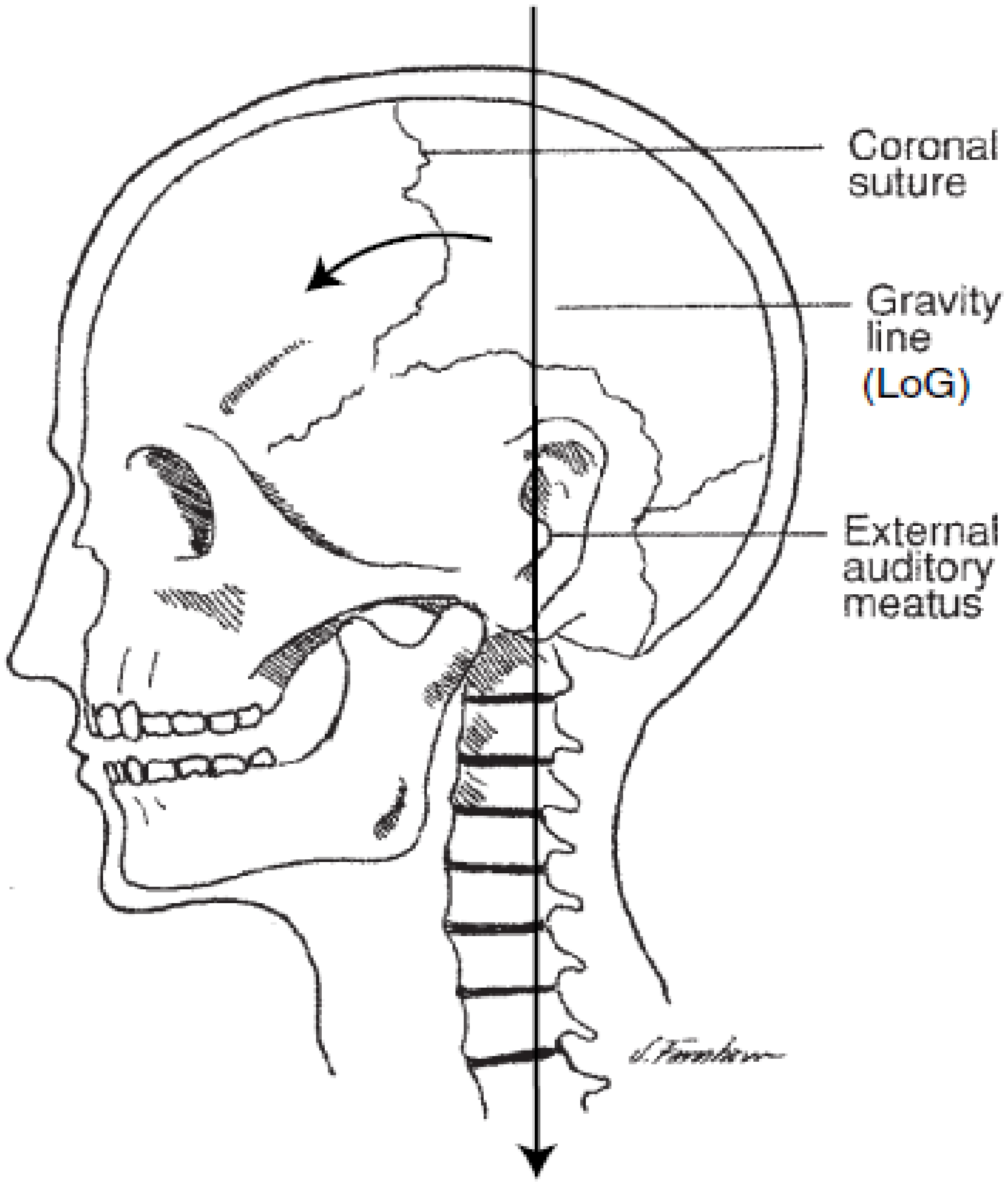
THE VERTEBRAL COLUMN:

- In optimal posture the position of the plumb line is through the midline of the trunk



HEAD:

- The LoG in relation to the head passes slightly anterior to the transverse (frontal) axis of rotation for flexion and extension of the head and creates an external flexion moment.



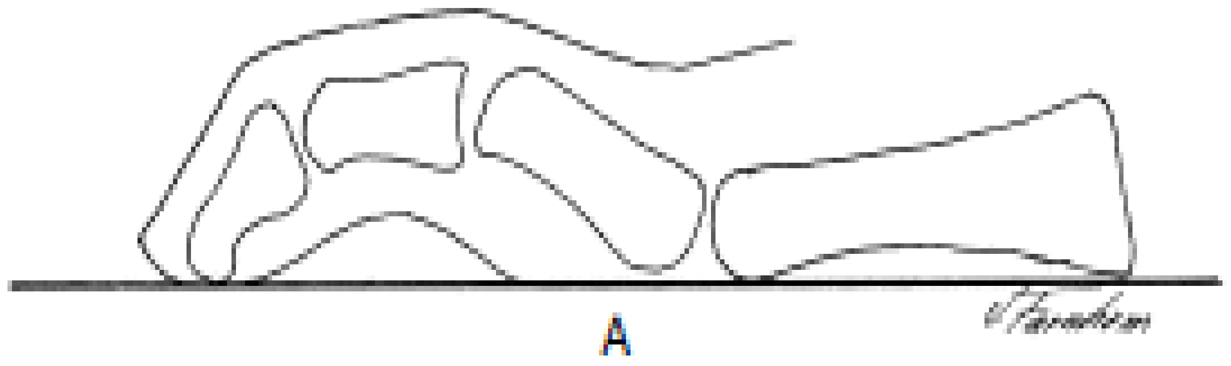
- This external flexion moment, which tends to tilt the head forward, may be counteracted by internal moments generated by tension in the ligamentum nuchae, tectorial membrane, and posterior aspect of the zygapophyseal joint capsules and by activity of the capital extensors.
- Ideally, a plumb line extending from the ceiling should pass through the external auditory meatus of the ear, and the head should be directly over the body’s CoM at S2.

DEVIATIONS FROM OPTIMAL ALIGNMENT VIEWED FROM THE SIDE (SAGITTAL VIEW)

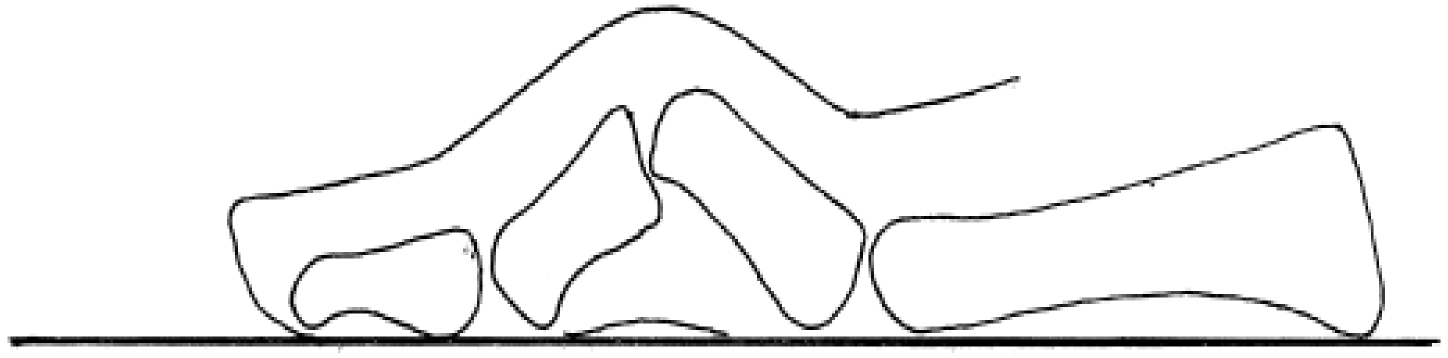
FOOT AND TOES:

❖ **CLAW TOES:**

- Claw toes is a deformity of the toes characterized by hyperextension of the metatarsophalangeal (MTP) joint, combined with flexion of the proximal interphalangeal (PIP) and distal interphalangeal (DIP) joints.



- The abnormal distribution of weight may result in callus formation under the heads of the metatarsals or under the end of the distal phalanx. Sometimes the proximal phalanx may subluxate dorsally on the metatarsal head.
- Calluses may develop on the dorsal aspects of the flexed phalanges from constant rubbing on the inside of shoes.



HAMMER TOES:

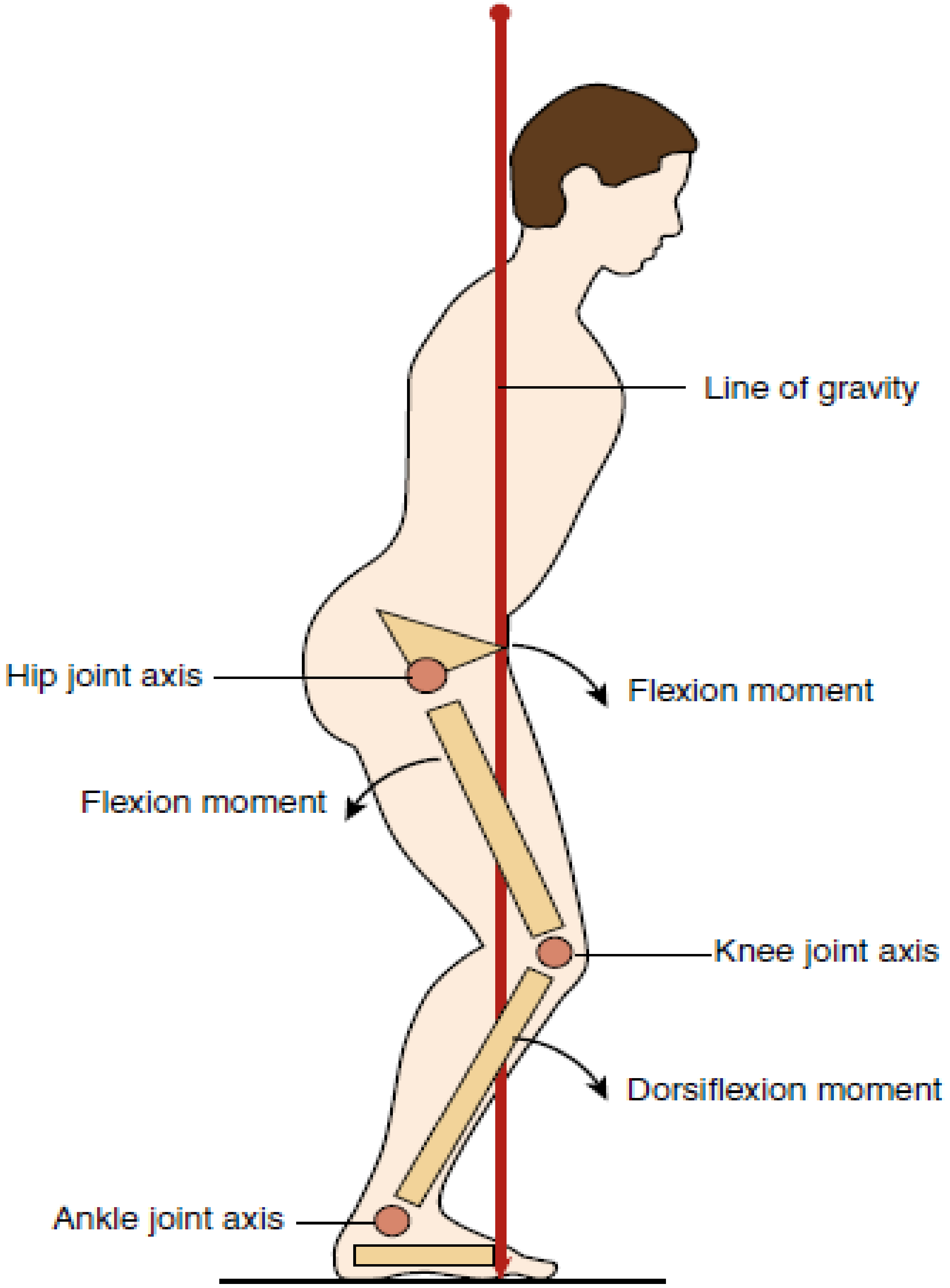
- In general, hammer toe is described as a deformity characterized by hyperextension of the metatarsophalangeal joint, flexion of the proximal interphalangeal joint, and hyperextension of the distal interphalangeal joint.
- Callosities (painless thickenings of the epidermis) may be found on the superior surfaces of the proximal interphalangeal joints over the heads of the first phalanges as a result of pressure from the shoes.

- The tips of the distal phalanges also may show callosities as a result of abnormal weight-bearing.
- The flexor muscles are stretched over the metatarsophalangeal joint and shortened over the proximal interphalangeal joint.
- The extensor muscles are shortened over the metatarsophalangeal joint and stretched over the proximal interphalangeal joint.

KNEE:

FLEXED KNEE POSTURE

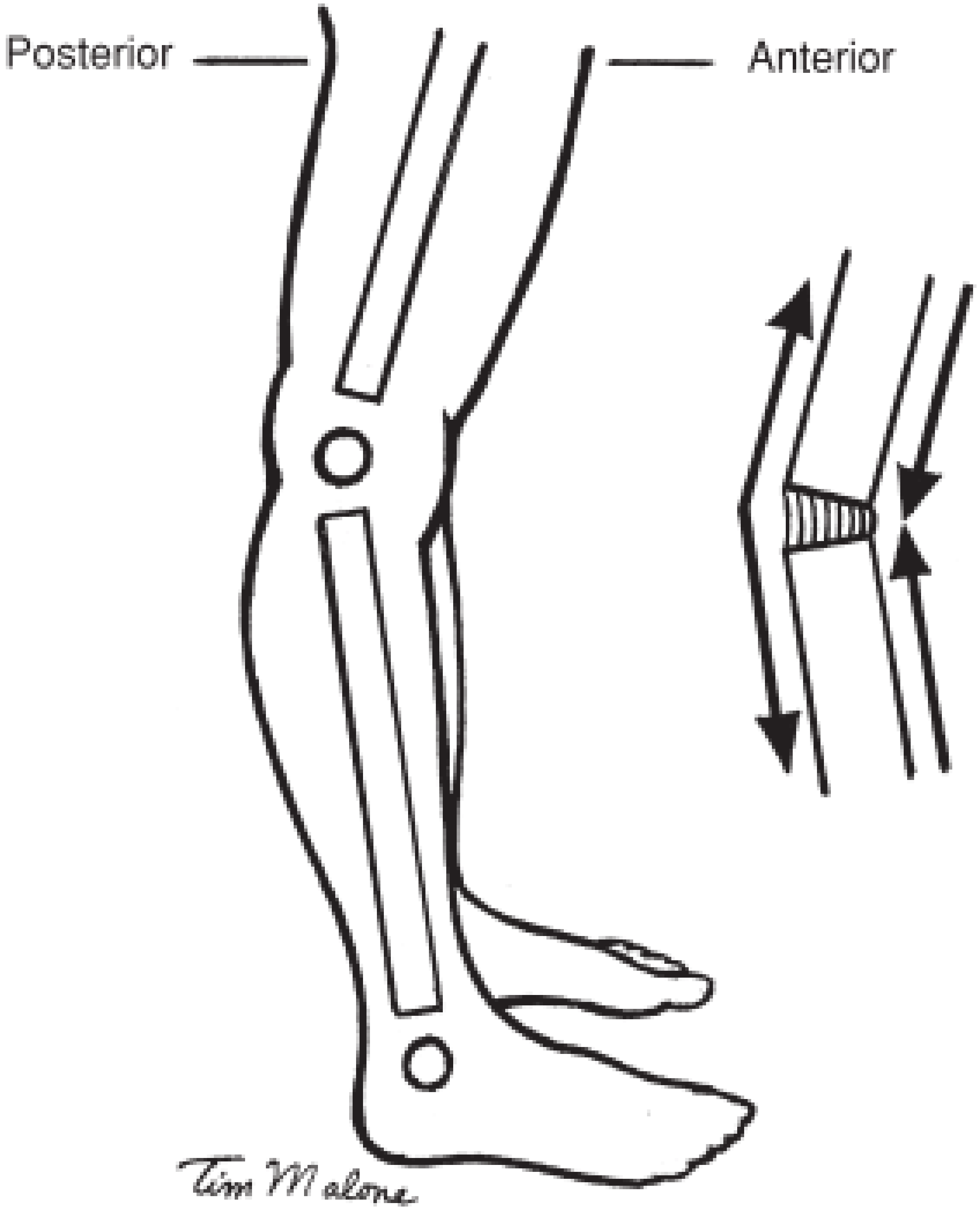
- In the flexed-knee standing posture, which can result from knee flexion contractures, the LoG passes posterior to the knee joint axes.



- The posterior location of the LoG creates an external flexion moment at the knees that must be balanced by an internal extension moment created by activity of the quadriceps muscles in order to maintain the erect position.
- The increase in muscle activity needed to maintain a flexed knee posture subjects the tibiofemoral and patellofemoral joints to greater-than-normal compressive stress and can lead to fatigue of the quadriceps femoris and other muscles if the posture is maintained for a prolonged period.

HYPEREXTENDED KNEE POSTURE (GENU RECURVATUM):

- The hyperextended knee posture is one in which the LoG is located considerably anterior to the knee joint axis.
- The anterior location of the LoG causes an increase in the external extensor moment acting at the knee, which tends to increase the extent of hyperextension and puts the posterior joint capsule under considerable tension stress.


Posterior
Anterior
Tim Malone

- A continual adoption of the hyperextended knee posture is likely to result in adaptive lengthening of the posterior capsule and of the cruciate ligaments and, consequently, in a more unstable joint.
- The anterior portion of the knee joint surfaces on the femoral condyles and anterior portion of the tibial plateaus will be subject to abnormal compression and therefore are subject to degenerative changes of the cartilaginous joint surfaces.

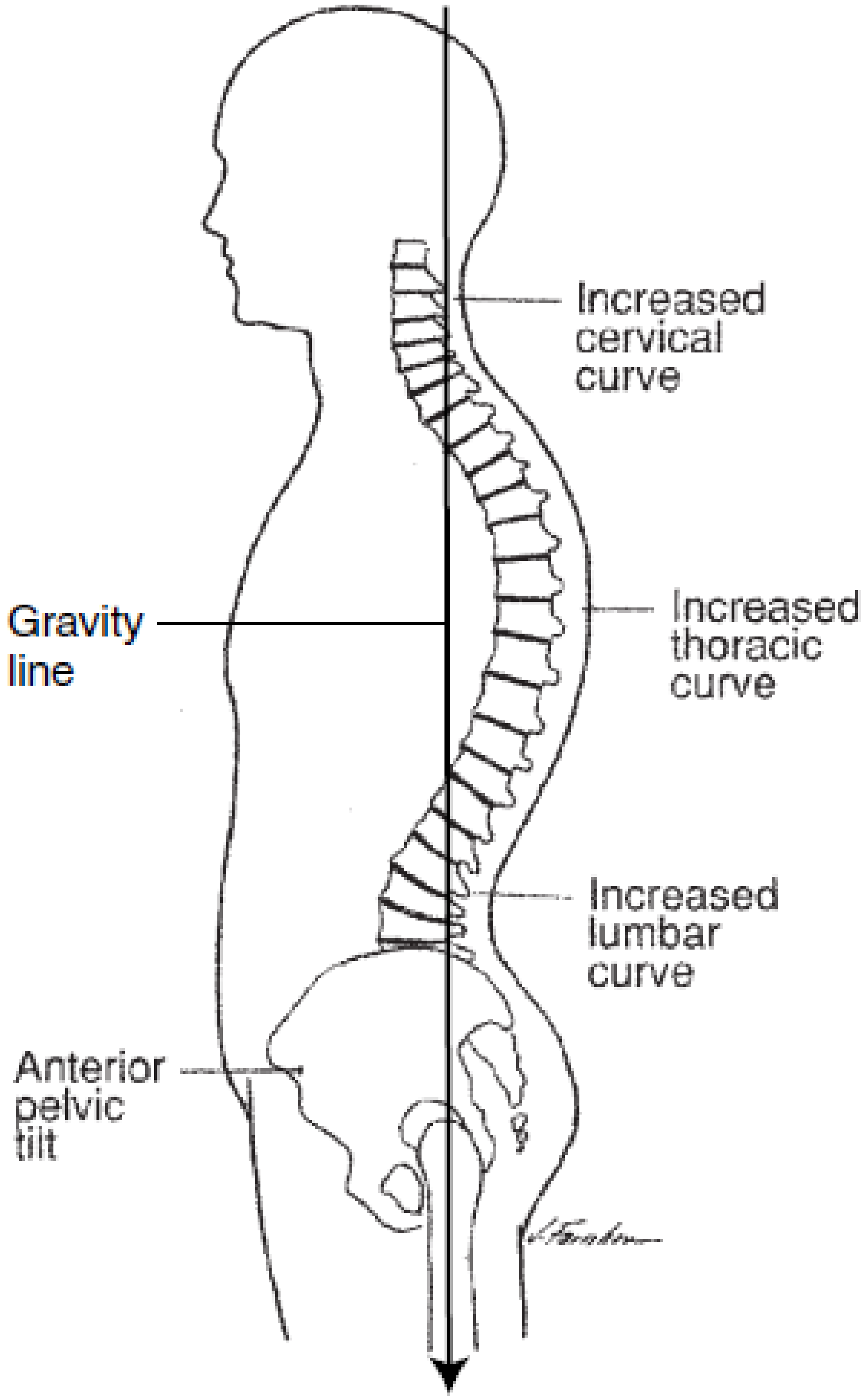
PELVIS:

EXCESSIVE ANTERIOR PELVIC TILT:

- In a posture in which the pelvis is excessively tilted anteriorly, the lower lumbar vertebrae are forced anteriorly.
- The upper lumbar vertebrae move posteriorly to keep the head over the sacrum, thereby increasing the lumbar anterior convexity (lordotic curve).

- The LoG is therefore at a greater distance from the lumbar joint axes than is optimal and the extension moment in the lumbar spine is increased.
- The posterior convexity of the thoracic curve increases and becomes kyphotic to balance the lordotic lumbar curve and maintain the head over the sacrum.
- Similarly, the anterior convexity of the cervical curve increases to bring the head back over the sacrum.

- Increases in the anterior convexity of the lumbar curve during erect standing increases the compressive forces on the posterior annuli and may adversely affect the nutrition of the posterior portion of the intervertebral discs.
- Also, excessive compressive forces may be applied to the zygapophyseal joints.



EXCESSIVE POSTERIOR PELVIC TILT:

- A posterior pelvic tilt causes a straightening of the lumbar spine and the subsequent loss of flexibility. It also causes some loss of the ability of the vertebral column to withstand as high a load as it did when the lumbar spine had a normal lordosis.

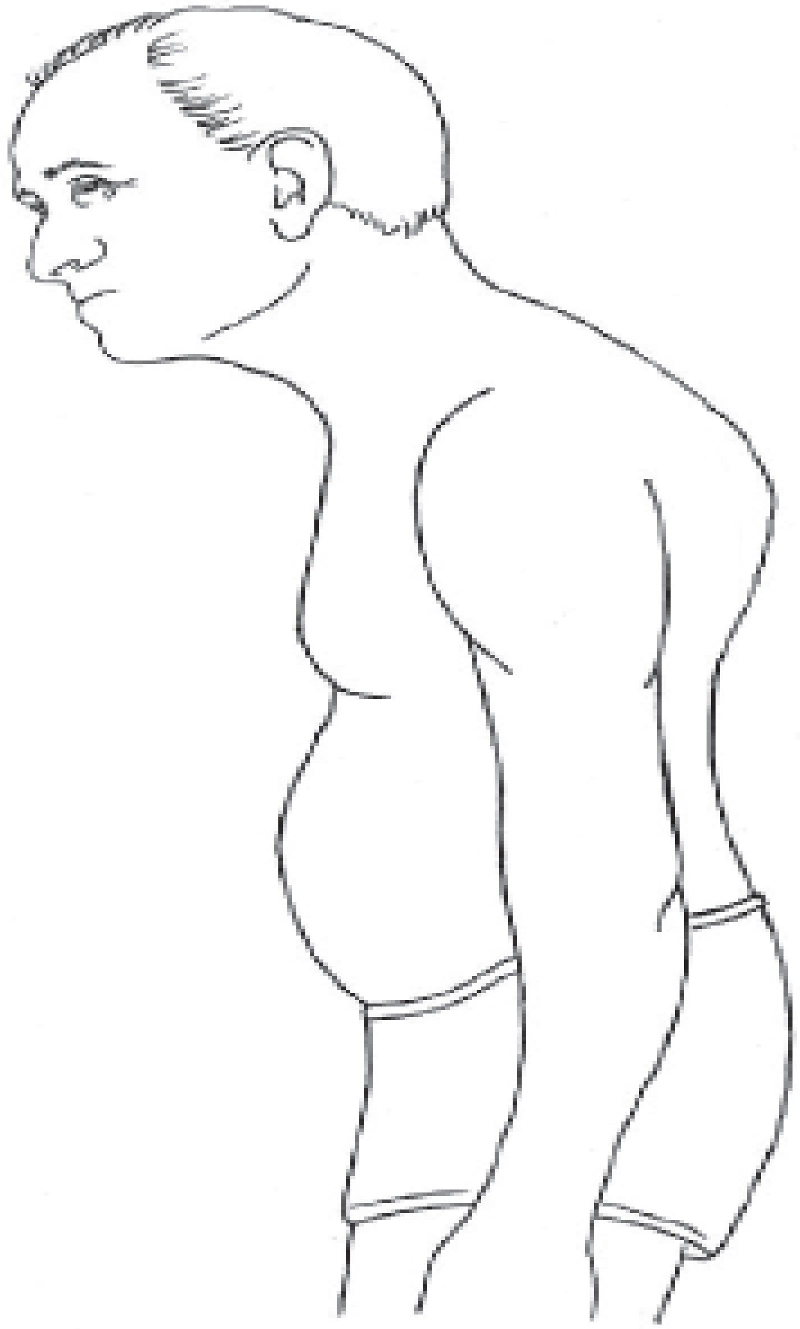
VERTEBRAL COLUMN

KYPHOSIS AND LORDOSIS

- The term **kyphosis** refers to the normal posteriorly convex curves in the thoracic and sacral regions of the vertebral column.
- Sometimes an abnormal increase in the normal thoracic posterior convexity may occur, and this abnormal condition also may be called a kyphosis.

- This condition may develop as a compensation for an increase in the normal lumbar curve, or the kyphosis may develop as a result of poor postural habits or osteoporosis.
- Two excessively kyphotic conditions, dowager's hump and gibbus deformity, both lead to vertebral fractures, although they are due to different causes.

A Dowager's hump



B Gibbus deformity

- Dowager’s hump is found most often in postmenopausal women who have osteoporosis.
- The anterior aspect of the bodies of a series of vertebrae may collapse as a result of osteoporotic weakening combined with increased compression stress on the anterior portions of the vertebral body

- The vertebral body collapse causes an immediate lack of anterior support for a segment of the thoracic vertebral column, which bends further forward, causing an increase in the posterior convexity and an increase in compression on the anterior aspect of the vertebral bodies and the anterior annulus.

- The term **lordosis** refers to the normal anterior convexity (posterior concavity) of the curves in the lumbar and cervical regions of the spine and also to abnormal increases in the curves usually in the lumbar region.
- Compression on the posterior aspects of the vertebrae and the posterior annulus are increased and tensile forces are increased on the anterior aspects of the vertebrae and the anterior longitudinal ligament.

HEAD

FORWARD HEAD POSTURE

- A forward head posture is one in which the 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.

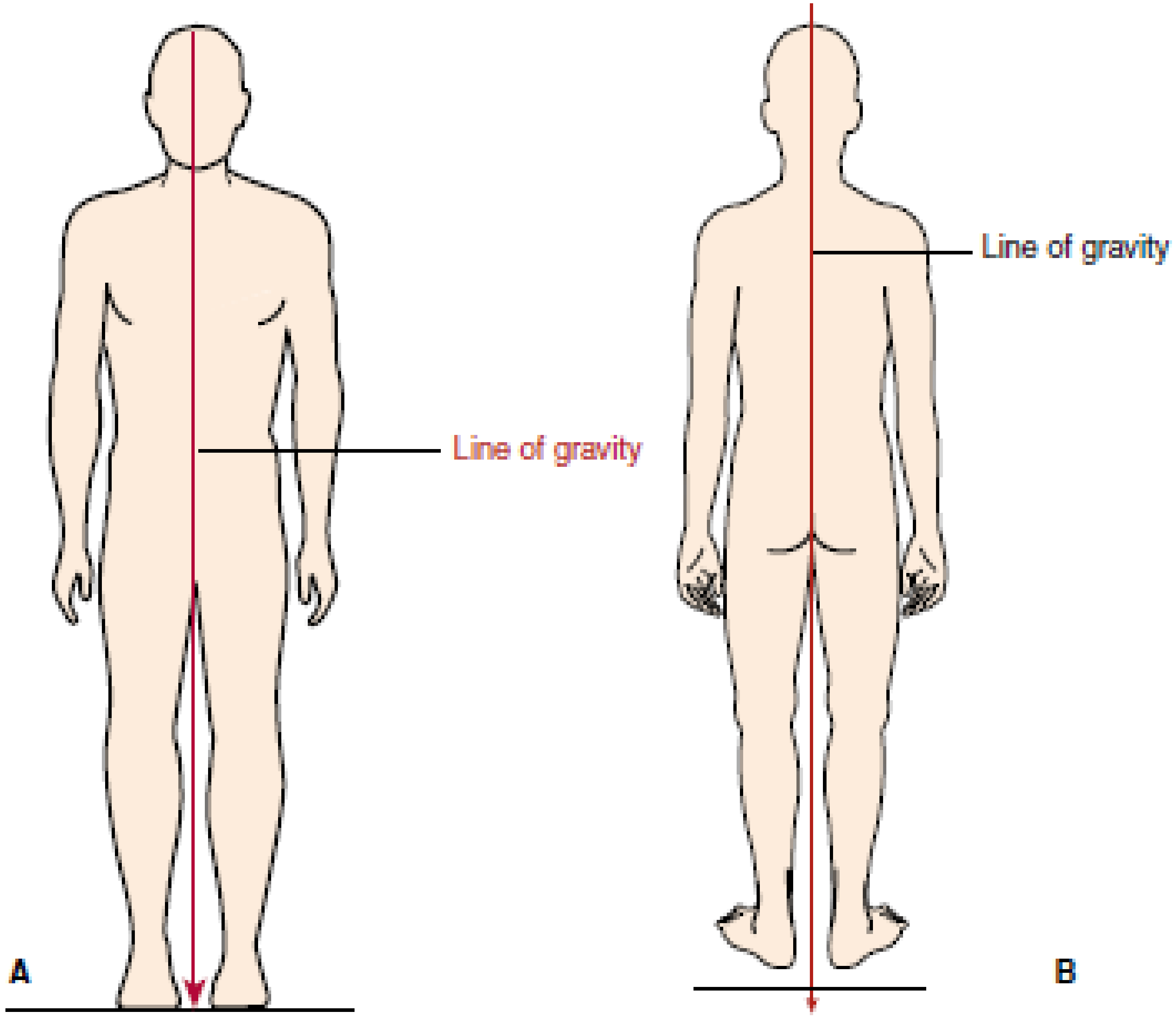
- The constant assumption of a forward head posture causes abnormal compression on the posterior zygapophyseal joints and posterior portions of the intervertebral discs and narrowing of the intervertebral foramina in the lordotic areas of the cervical region.
- In the forward head posture, the scapulae may rotate medially, a thoracic kyphosis may develop, the thoracic cavity may be diminished, vital capacity can be reduced, and overall body height may be shortened.

OPTIMAL ALIGNMENT AND ANALYSIS: ANTERIOR AND POSTERIOR VIEWS

- In both anterior and posterior views, the LoG bisects the body into symmetrical halves.
- The head is straight, with no tilting or rotation evident, and the face is bisected into equal halves.
- The eyes, clavicles, and shoulders should be level (parallel to the ground).
- In a posterior view, the inferior angles of the scapulae should be parallel and equidistant from the LoG.

- The waist angles and gluteal folds should be equal, and the anterior superior iliac spines and posterior superior iliac spines should lie on a line parallel to the ground, as well as being equidistant from the LoG.
- The joint axes of the hip, knee, and ankle are equidistant from the LoG, and the gravitational line transects the central portion of the vertebral bodies.

- When postural alignment is optimal, little or no muscle activity is required to maintain medial lateral stability.
- The gravitational torques acting on one side of the body are opposed by equal torques acting on the other side of the body



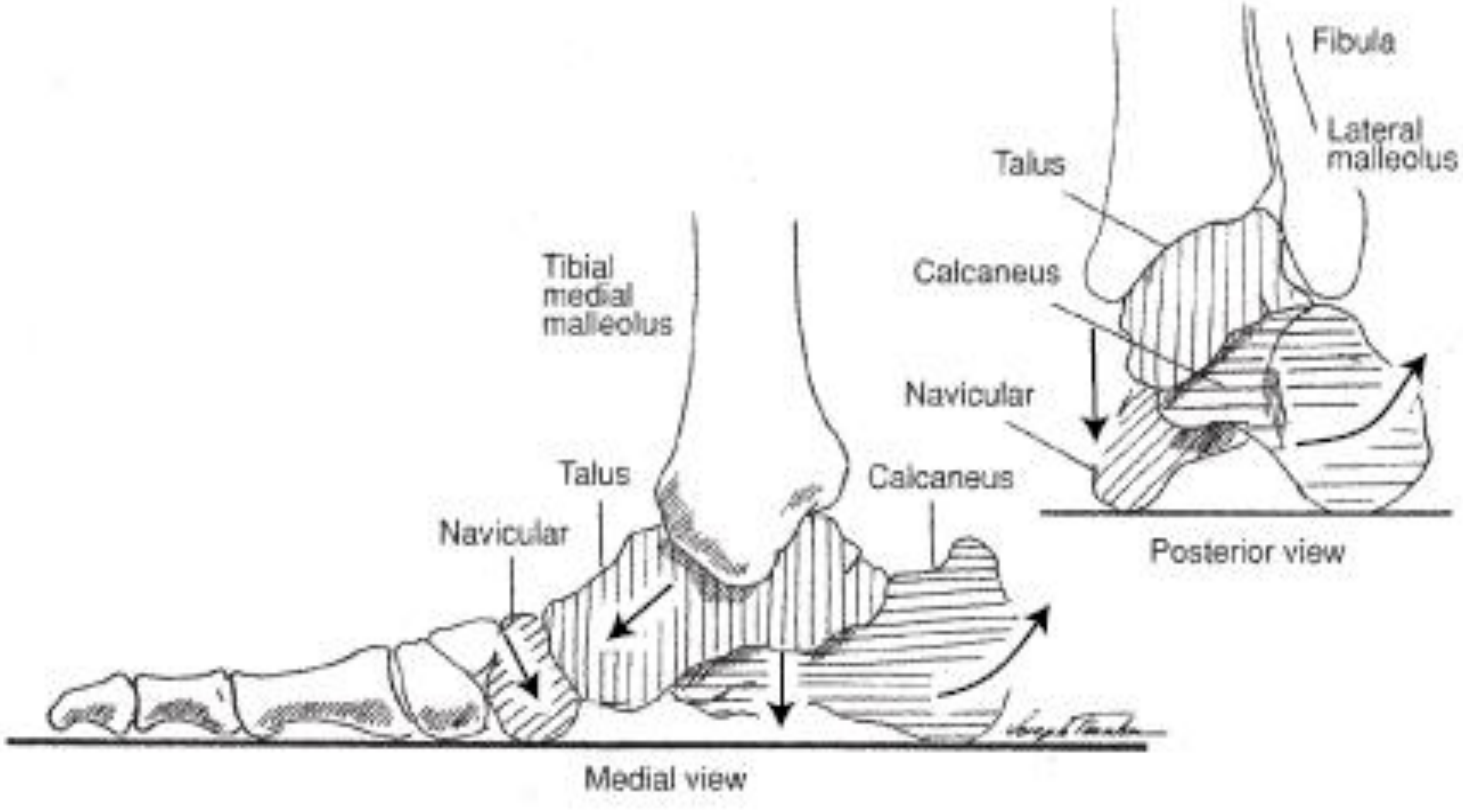
DEVIATIONS FROM OPTIMAL ALIGNMENT: FRONTAL PLANE

FOOT AND TOES

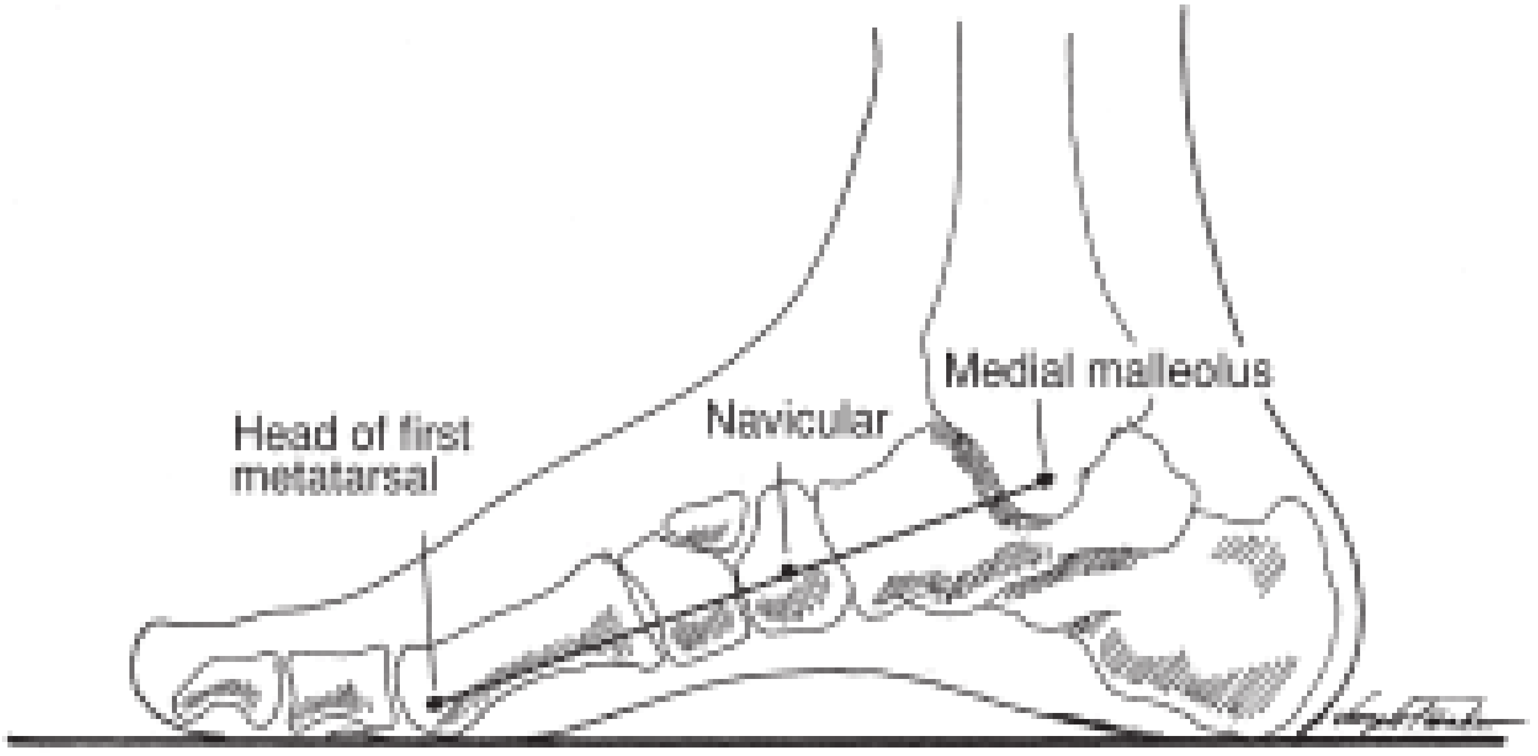
PES PLANUS (FLAT FOOT):

- Flat foot, which is characterized by a reduced or absent medial arch, may be either rigid or flexible.
- A rigid flat foot is a structural deformity that may be hereditary. In the rigid flat foot, the medial longitudinal arch is absent in non weight bearing, toe-standing, and normal weight-bearing situations.

- In the flexible flat foot, the arch is reduced during normal weight-bearing situations but reappears during toe-standing or non-weight bearing situations.
- In either the rigid or flexible type of pes planus, the talar head is displaced anteriorly, medially, and inferiorly. The displacement of the talus causes depression of the navicular bone, tension in the plantar calcaneonavicular (spring) ligament, and lengthening of the tibialis posterior muscle.


Fibula
Lateral malleolus
Talus
Calcaneus
Navicular
Posterior view
Tibial medial malleolus
Talus
Calcaneus
Navicular
Medial view

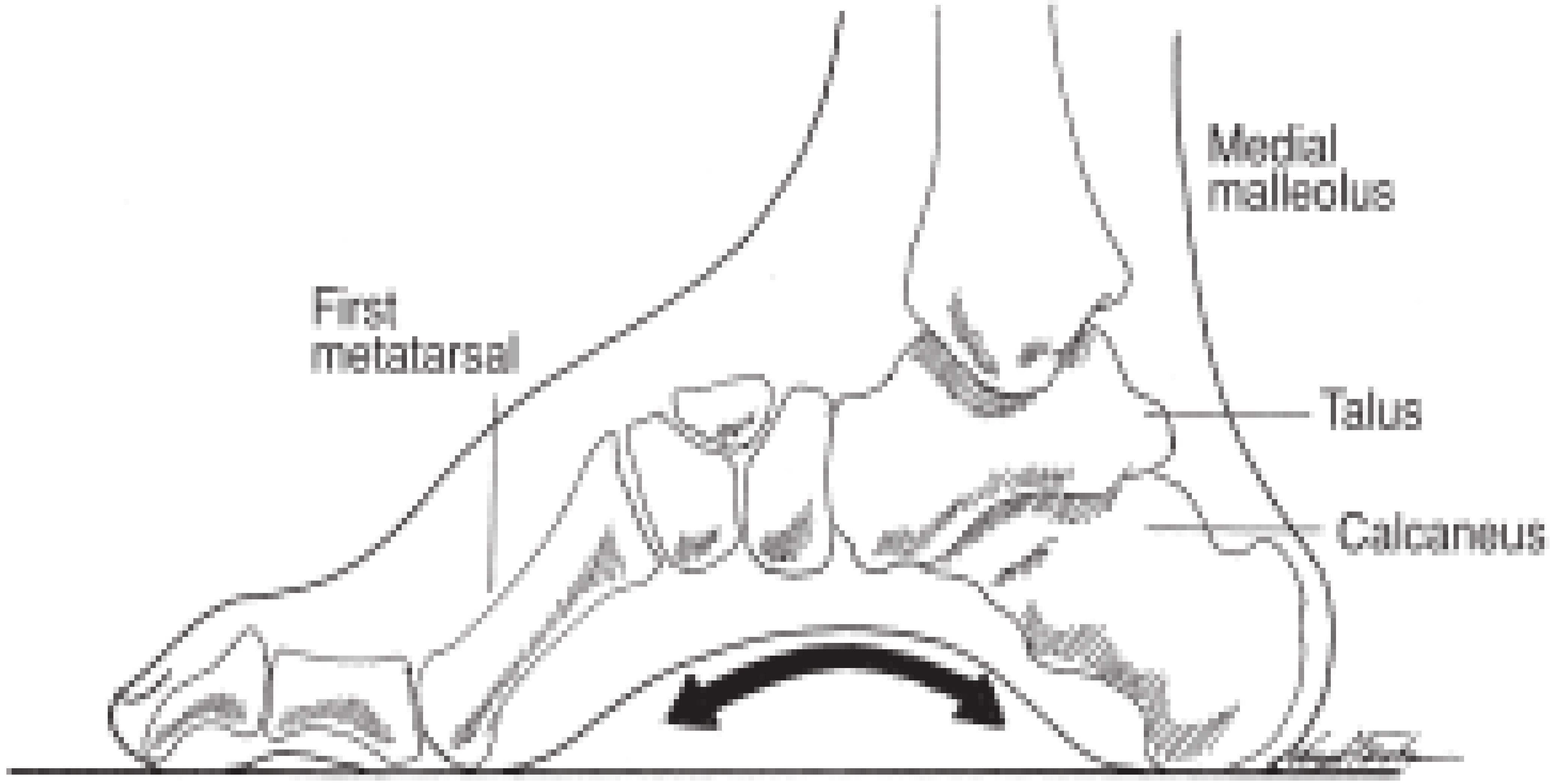
- The extent of flat foot may be estimated by noting the location of the navicular bone in relation to the head of the first metatarsal.
- Normally, the navicular bone should be intersected by the Feiss line.



- If the navicular bone is depressed, it will lie below the Feiss line and may even rest on the floor in a severe case of flat foot.
- It also may result in increased weight-bearing on the second through fourth metatarsal heads with subsequent plantar callus formation, especially at the second metatarsal.
- Weight-bearing pronation in the erect standing posture causes medial rotation of the tibia and may affect knee joint function.

PES CAVUS:

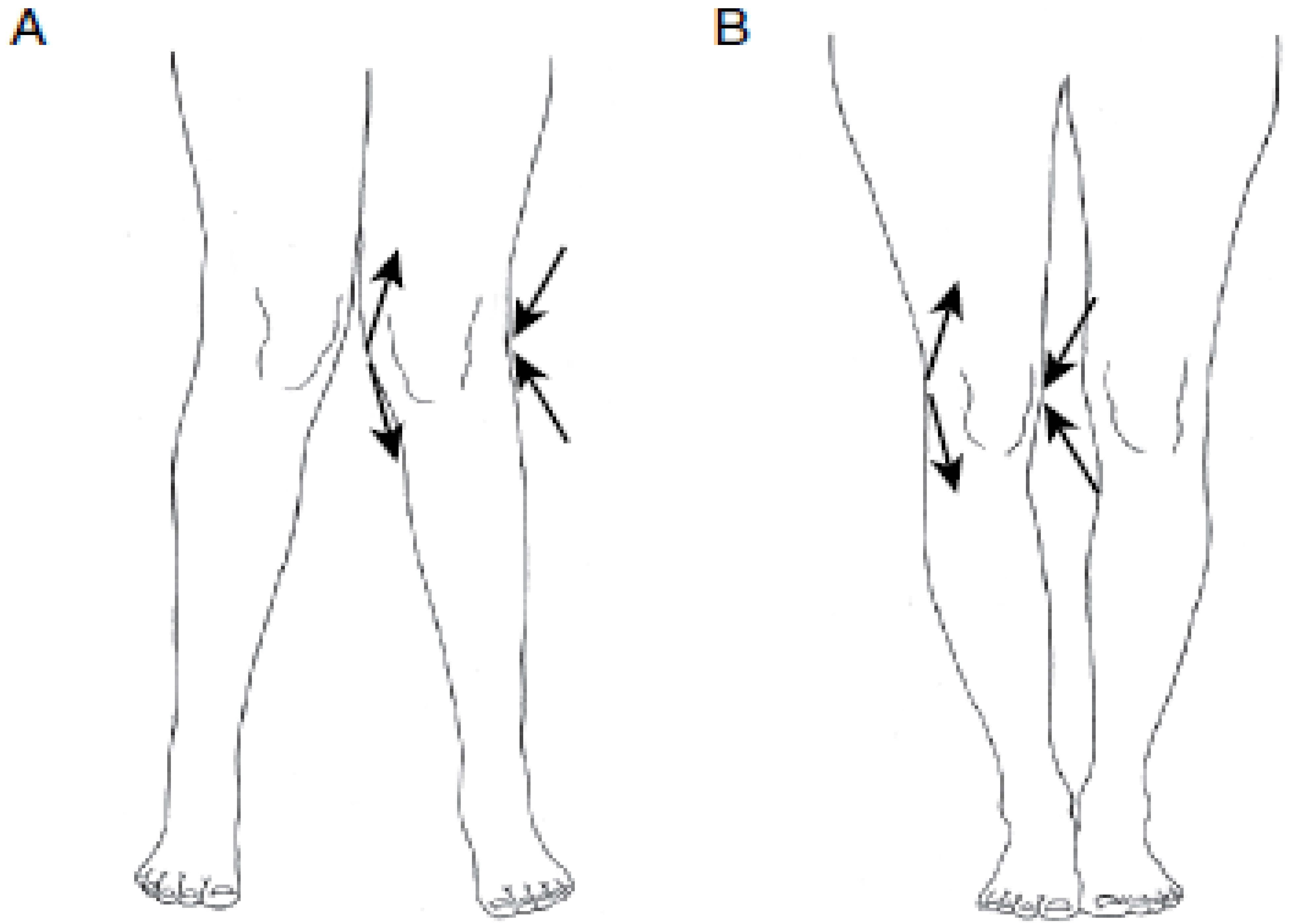
- The medial longitudinal arch of the foot, instead of being low (as in flat foot), may be unusually high.
- A high arch is called **pes cavus**. Pes cavus is a more stable position of the foot than is pes planus; however, the weight in pes cavus is borne on the lateral borders of the foot, and the lateral ligaments and the peroneus longus muscle may be stretched.


Medial
malleolus
First
metatarsal
Talus
Calcaneus

KNEE:

GENU VALGUM (KNOCK KNEE)

- In genu valgum, the mechanical axes of the lower extremities are displaced laterally.
- As a result of the increased external torque acting around the knee, the medial knee joint structures are subjected to abnormal tensile or distraction stress, and the lateral structures are subjected to abnormal compressive stress. The patella may be laterally displaced and therefore predisposed to subluxation.


A
B

- The foot also is affected as the gravitational torque acting on the foot in genu valgum tends to produce pronation of the foot with an accompanying stress on the medial longitudinal arch and its supporting structures, as well as abnormal weight-bearing on the posterior medial aspect of the calcaneus (valgus torque).
- Additional related changes may include flat foot, lateral tibial torsion, lateral patellar subluxation, and lumbar spine contralateral rotation.

GENU VARUM (BOWLEG)

- **Genu varum (bowleg)** is a condition in which the knees are widely separated when the feet are together and the malleoli are touching.
- Cortical thickening on the medial concavity of both the femur and tibia may be present as a result of the increased compressive forces, and the patellae may be displaced medially.
- Some of the more commonly suggested cause of genu varum are vitamin D deficiency, renal rickets, osteochondritis, or epiphyseal injury.

VERTEBRAL COLUMN

SCOLIOSIS:

- Consistent lateral deviations of a series of vertebrae from the LoG in one or more regions of the spine may indicate the presence of a lateral spinal curvature in the frontal plane called a **scoliosis**.
- There are two classifications of curves: **functional curves** and **structural curves.**

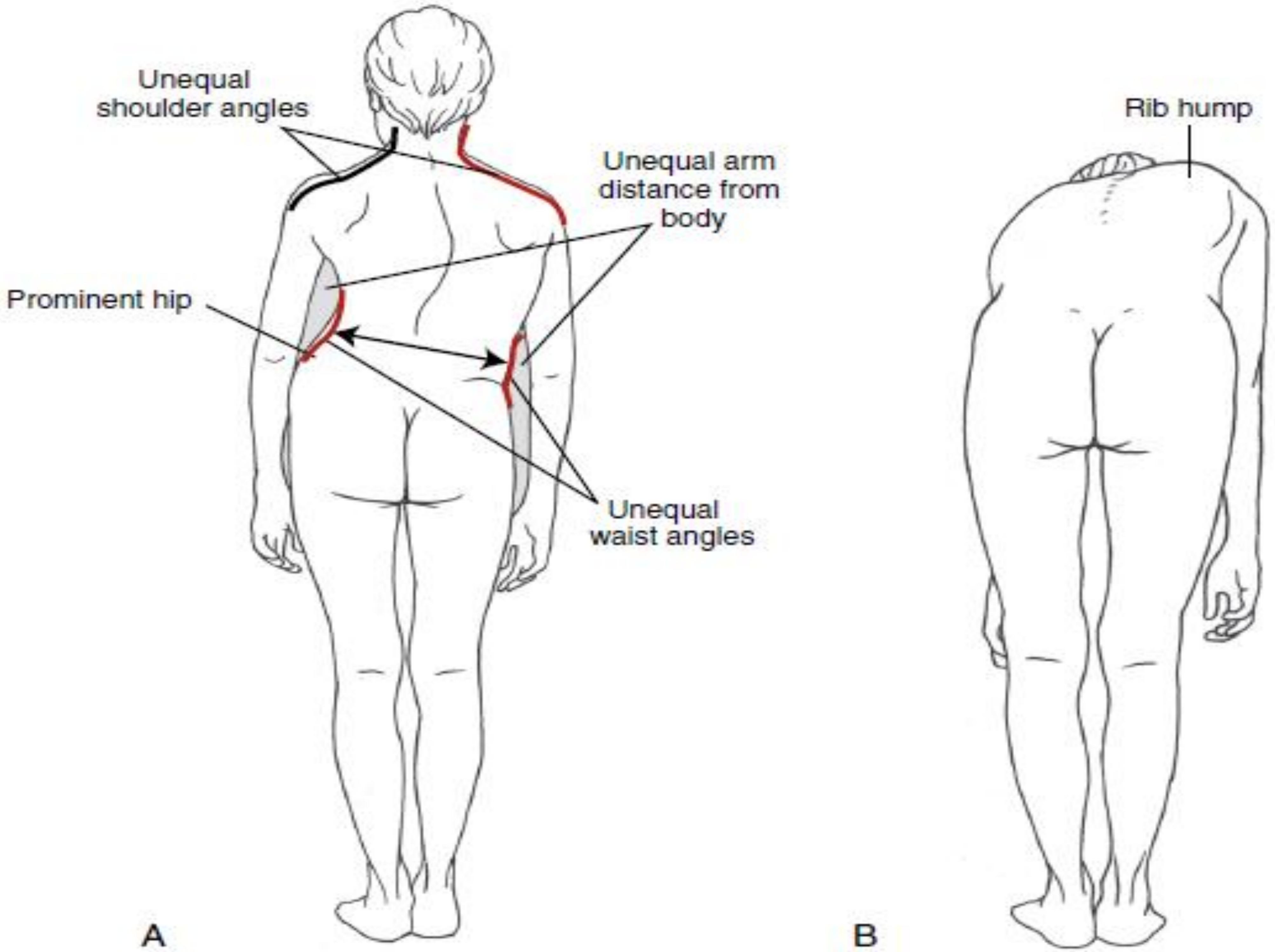

58°
R.W.
6/72
31°

- Functional curves are called non-structural curves in that they can be reversed if the cause of the curve is corrected.
- These curves are the result of correctable imbalances such as a leg length discrepancy or a muscle spasm.
- Structural curves, as the name implies, involve changes in bone and soft tissue structures.

- Although scoliosis is usually identified as a lateral curvature of the spine in the frontal plane, the deformity also occurs in the transverse (as vertebrae rotate) and sagittal planes (as the column buckles).
- Idiopathic (cause unknown) scoliosis are categorized by age at onset: **infantile** (0 to 3 years), **juvenile** (4 to 10 years), and **adolescent** (older than 10 years).

- The curves in scoliosis are named according to the direction of the convexity and location of the curve.
- If the curve is convex to the left in the cervical area, the curve is designated as a left cervical scoliosis.
- If more than one region of the vertebral column is involved, the superior segment is named first (e.g., left cervical, right thoracic).

- The vertebral deviations in scoliosis cause asymmetrical changes in body structures, and several of these changes may be detected through simple observation of body contours either at home or in the schools.
- Usually, home or school screening programs are designed for identification of the following: **unequal waist angles, unequal shoulder levels or unequal scapulae**, **rib hump, and obvious lateral spinal curvature.**


Unequal
shoulder angles
Unequal arm
distance from
body
Prominent hip
Unequal
waist angles
A
Rib hump
B