Chapter 8: Joints of the Lower Extremity

Joseph E. Muscolino, DC
Lesson 8.1 Objectives

• Define the key terms of this chapter and state the meanings of the word origins of this chapter.

• Describe the structure of the pelvis and explain the difference between intrapelvic motion and motion of the pelvis relative to an adjacent body part.

• Describe the sacral movements of nutation and counternutation.
Lesson 8.1 Objectives (cont’d.)

• Describe and compare movements of the pelvis at the lumbosacral and hip joints.

• Explain the reverse action relationships between pelvic movements and movements of the trunk and thighs.
Joints of the Lower Extremity

- Symphysis pubis joint
- Sacroiliac joints
- Lumbosacral joint
- Hip joints
- Knee joint complex
- Tibiofibular joints
Joints of the Lower Extremity (cont’d.)

• Talocrural (ankle) joint
• Tarsal joints
• Tarsometatarsal joints
• Intermetatarsal joints
• Metatarsophalangeal (MTP) joints
• Interphalangeal (IP) joints
Section 8.1—Introduction to the Pelvis

[Image of a pelvis bone with labels: Sacrum and coccyx, Right pelvic bone, Left pelvic bone]
Section 8.1—Introduction to the Pelvis (cont’d.)

Joints Located within the Pelvis:
- Symphysis pubis joint
- Sacroiliac joints

Pelvic Motion:
- Intrapelvic motion
- Motion of pelvis as a unit relative to an adjacent body part
Section 8.2—Intrapelvic Motion

- Sacroiliac joints
- Lumbosacral joint
- Hip joint
- Symphysis pubis joint
- Arcuate ligament
Section 8.2—Intrapelvic Motion (cont’d.)

Symphysis Pubis Joint:

- **Structure**: Cartilaginous joint
  - Symphysis joint
- **Function**: Amphiarthrotic
- **Major motions**: Nonaxial gliding
- **Major ligaments**: Arcuate pubic ligament
Section 8.2—Intrapelvic Motion (cont’d.)

Sacroiliac Joints:

- Structure: Mixed synovial/fibrous joint
  - Plane joint
- Function: Mixed diarthrotic/amphiarthrotic
Section 8.2—Intrapelvic Motion (cont’d.)

Sacroiliac Joints (cont’d.):

- Major motions allowed:
  - Nonaxial gliding
  - Nutation and counternutation
Section 8.2—Intrapelvic Motion (cont’d.)

Sacral Joints (cont’d.):

• Major ligaments of the SI joint:
  – Sacroiliac ligaments
  – Sacrotuberous ligament
  – Sacrospinous ligament
  – Iliolumbar ligament
Section 8.2—Intrapelvic Motion (cont’d.)

Sacroiliac Joints (cont’d.):
Section 8.3—Movement of the Pelvis at the Lumbosacral Joint

A

Posterior tilt

B

Anterior tilt
Section 8.3—Movement of the Pelvis at the Lumbosacral Joint (cont’d.)
Section 8.3—Movement of the Pelvis at the Lumbosacral Joint (cont’d.)

E: Right rotation of the pelvis
F: Left rotation of the pelvis
Section 8.4—Movement of the Pelvis at the Hip Joints
Section 8.4—Movement of the Pelvis at the Hip Joints (cont’d.)
Section 8.4—Movement of the Pelvis at the Hip Joints (cont’d.)
Section 8.5—Movement of the Pelvis at the Lumbosacral and Hip Joints

Average Ranges of Motion:

- Anterior tilt: 30 degrees
- Posterior tilt: 15 degrees
- Right depression: 30 degrees
- Left depression: 30 degrees
- Right rotation: 15 degrees
- Left rotation: 15 degrees
Section 8.5—Movement of the Pelvis at the Lumbosacral and Hip Joints (cont’d.)

Figure 8-8
(Modified from Neumann DA: Kinesiology of the musculoskeletal system: foundations for physical rehabilitation, ed 2, St Louis, 2010, Mosby.)
Section 8.6—Relationship of Pelvic/SpinalMovements at the Lumbosacral Joint

- Sagittal plane movements
- Frontal plane movements
- Transverse plane movements
Section 8.6—Relationship of Pelvic/Spinal Movements at the Lumbosacral Joint (cont’d.)

A. Neutral position
B. Posterior tilt of the pelvis
C. Flexion of the trunk

Paraspinal musculature
Anterior abdominal wall musculature
Section 8.6—Relationship of Pelvic/Spinal Movements at the Lumbosacral Joint (cont’d.)

A. Neutral position
B. Anterior lift of the pelvis
C. Extension of the trunk

Paraspinal musculature
Anterior abdominal wall musculature
Section 8.6—Relationship of Pelvic/Spinal Movements at the Lumbosacral Joint (cont’d.)

- Figure 8-10
  - A: Neutral position
  - B: Elevation of the right pelvis (and depression of the left pelvis)
  - C: Right lateral flexion of the trunk

Copyright © 2011, 2007 by Mosby, Inc., an affiliate of Elsevier Inc. All rights reserved.
Section 8.6—Relationship of Pelvic/Spinal Movements at the Lumbosacral Joint (cont’d.)

Right rotation of the pelvis

Left rotation of the trunk
Section 8.7—Relationship of Pelvic/Thigh Movements at the Hip Joint

- Sagittal plane movements
- Frontal plane movements
- Transverse plane movements
Section 8.7—Relationship of Pelvic/Thigh Movements at the Hip Joint (cont’d.)

A. Neutral position

B. Anterior tilt of the pelvis

C. Flexion of the thigh
Section 8.7—Relationship of Pelvic/Thigh Movements at the Hip Joint (cont’d.)

A. Neutral position

B. Hip extensor musculature

C. Hip flexor musculature

D. Posterior tilt of the pelvis

E. Extension of the thigh
Section 8.7—Relationship of Pelvic/Thigh Movements at the Hip Joint (cont’d.)

A. Neutral position

B. Depression of the right pelvis (and elevation of the left pelvis)

C. Abduction of the right thigh
Section 8.7—Relationship of Pelvic/Thigh Movements at the Hip Joint (cont’d.)

A. Neutral position

B. Elevation of the right pelvis (and depression of the left pelvis)

C. Adduction of the right thigh
Section 8.7—Relationship of Pelvic/Thigh Movements at the Hip Joint (cont’d.)

A

Neutral position

Lateral rotator musculature

Medial rotator musculature

B

Left (contralateral) rotation of the pelvis

C

Lateral rotation of the right thigh
Section 8.7—Relationship of Pelvic/Thigh Movements at the Hip Joint (cont’d.)

- Lateral rotator musculature
- Medial rotator musculature

A. Neutral position

D. Right (ipsilateral) rotation of the pelvis

E. Medial rotation of the right thigh
Lesson 8.2 Objectives

• Explain the relationship between pelvic posture (and, specifically, the sacral base angle) and spinal posture.

• Discuss the meaning of open-chain and closed-chain activities and give examples of each.
Lesson 8.2 Objectives (cont’d.)

• Explain the concepts of the femoral angle of inclination and femoral torsion angle, and explain the possible consequences of these femoral angulations.

• Describe and give an example of the concept of femoropelvic rhythm.
Joints of the Lower Extremity

• Symphysis pubis joint
• Sacroiliac joints
• Lumbosacral joint
• Hip joints
• Knee joint complex
• Tibiofibular joints
Joints of the Lower Extremity (cont’d.)

- Talocrural (ankle) joint
- Tarsal joints
- Tarsometatarsal joints
- Intermetatarsal joints
- Metatarsophalangeal (MTP) joints
- Interphalangeal (IP) joints
Section 8.8—Effect of Pelvic Posture on Spinal Posture

• Sacral base angle
• Lumbopelvic rhythm
• Righting reflex
Section 8.8—Effect of Pelvic Posture on Spinal Posture (cont’d.)

A

B

C
Section 8.9—Hip Joint

Anterior view

Pelvic bone

Head of the femur
Section 8.9—Hip Joint
(cont’d.)

Structure Classification:
• Synovial joint
  – Ball-and-socket

Function Classification:
• Diarthrotic
  – Triaxial
Section 8.9—Hip Joint (cont’d.)

Major Motions Allowed:
- Flexion and extension of thigh
- Abduction and adduction of thigh
- Medial rotation and lateral rotation of thigh

Reverse Actions:
- Movement of pelvis
Section 8.9—Hip Joint (cont’d.)

• Open-chain activity
  – Distal bone of joint free to move

• Closed-chain activity
  – Distal bone of joint fixed
Section 8.9—Hip Joint (cont’d.)

Figure 8-17

Insert Fig. 8-17 A and B
Section 8.9—Hip Joint (cont’d.)

Figure 8-17
Section 8.9—Hip Joint (cont’d.)

E  F
Section 8.9—Hip Joint (cont’d.)

Average Ranges of Motion:

- Flexion: 90 degrees
- Extension: 20 degrees
- Abduction: 40 degrees
- Adduction: 20 degrees
- Medial rotation: 40 degrees
- Lateral rotation: 50 degrees
Section 8.9—Hip Joint (cont’d.)

Major Ligaments of the Hip Joint:

- Fibrous joint capsule
  - Iliofemoral ligament
  - Pubofemoral ligament
  - Ischiofemoral ligament
- Ligamentum teres
Section 8.9—Hip Joint (cont’d.)

Closed-Packed Position:
- Full extension

Major Muscles of the Hip Joint:
- Anterior muscles
- Posterior muscles
- Medial muscles
- Lateral muscles
Section 8.10—Angulations of the Femur

Femoral Angles of Inclination:

A) 125°
B) 110°
C) 140°
Section 8.10—Angulations of the Femur (cont’d.)

Femoral Torsion Angles:

- Figure 8-20
Section 8.11—Femoropelvic Rhythm
Lesson 8.3 Objectives

- Explain the concepts of the angulations of the knee joint, namely, genu valgus, genu varum, Q-angle, and genu recurvatum.
- Describe and give an example of the concept of bowstringing.
- Describe tibial torsion.
Joints of the Lower Extremity

• Symphysis pubis joint
• Sacroiliac joints
• Lumbosacral joint
• Hip joints
• Knee joint complex
• Tibiofibular joints
Joints of the Lower Extremity (cont’d.)

• Talocrural (ankle) joint
• Tarsal joints
• Tarsometatarsal joints
• Intermetatarsal joints
• Metatarsoophalangeal (MTP) joints
• Interphalangeal (IP) joints
Section 8.12—Overview of the Knee Joint Complex

- Tibiofemoral joint
- Patellofemoral joint
Section 8.13—Tibiofemoral (Knee) Joint

Structure Classification:
- Synovial joint
  - Modified hinge joint

Function Classification:
- Diarthrotic
  - Biaxial
Section 8.13—Tibiofemoral (Knee) Joint (cont’d.)

Major Motions Allowed:
- Flexion and extension of leg
- Medial rotation and lateral rotation of leg

Reverse Actions:
- Flexion and extension of thigh
- Lateral rotation and medial rotation of thigh
Section 8.13—Tibiofemoral (Knee) Joint (cont’d.)
Section 8.13—Tibiofemoral (Knee) Joint (cont’d.)
Section 8.13—Tibiofemoral (Knee) Joint (cont’d.)

Average Ranges of Motion:

- Flexion: 140 degrees
- Extension: 5 degrees
- Medial rotation: 15 degrees
- Lateral rotation: 30 degrees
Section 8.13—Tibiofemoral (Knee) Joint (cont’d.)

Major Ligaments of the Knee Joint:

- Fibrous joint capsule
- Medial collateral ligament
- Lateral collateral ligament
- Anterior cruciate ligament
- Posterior cruciate ligament
Section 8.13—Tibiofemoral (Knee) Joint (cont’d.)

Figure 8-24
Modified from Neumann DA: Kinesiology of the musculoskeletal system: foundations for physical rehabilitation, ed 2, St Louis, 2010, Mosby
Figure 8-24
Modified from Neumann DA: Kinesiology of the musculoskeletal system: foundations for physical rehabilitation, ed 2, St Louis, 2010, Mosby
Section 8.13—Tibiofemoral (Knee) Joint (cont’d.)
Section 8.13—Tibiofemoral (Knee) Joint (cont’d.)

Closed-Packed Position:
• Full extension

Major Muscles of the Knee Joint:
• Anterior muscles
• Posterior muscles
• Medial muscles
• Lateral muscles
Section 8.13—Tibiofemoral (Knee) Joint (cont’d.)

• Menisci
  – Medial meniscus
  – Lateral meniscus

• Major bursae

• Screw-home mechanism
Section 8.14—Patellofemoral Joint

- Patella
- Intercyndylar groove
- Lateral condyle
- Medial condyle
- Lines of pull of quadriceps femoris
- Lever arms
- Axis of motion
- Tibial tuberosity
Section 8.14—Patellofemoral Joint (cont’d.)

Structure of the Patella:

- Medial facet
- Lateral facet
- Articular cartilage
Section 8.14—Patellofemoral Joint (cont’d.)

Major Motions Allowed:
- Superior and inferior gliding (nonaxial) movements

Closed-Packed Position:
- Flexion (of the knee joint)
Functions of the Patella:

- Acts as an anatomic pulley
- Reduces friction
- Protects the femoral condyles
Section 8.15—Angulations of the Knee Joint

Knee Joint Angulation Measurements:
- Genu valgum/varum
- Q-angle
- Genu recurvatum
Section 8.15—Angulations of the Knee Joint (cont’d.)

Figure 8-27

A
Excessive genu valgum

B
Genu varum

ASIS
Pull of quadriceps femoris

Center of patella
Tibial tuberosity

25°
10°
Q-angle
Section 8.15—Angulations of the Knee Joint (cont’d.)

Q-Angle:
Section 8.15—Angulations of the Knee Joint (cont’d.)

Bowstring Force:
Section 8.15—Angulations of the Knee Joint (cont’d.)

Genu Recurvatum:
Section 8.16—Tibiofibular Joints

Tibiofibular Joints:
- Proximal tibiofibular joint
- Middle tibiofibular joint
- Distal tibiofibular joint
Section 8.16—Tibiofibular Joints (cont’d.)

- Interosseus membrane
  - Two purposes
- Tibial torsion
  - Lateral twist of shaft of tibia
Lesson 8.4 Objectives

- List the regions of the foot and the joints of the foot.
- Compare and contrast the role of stability and flexibility of the foot.
Lesson 8.4 Objectives (cont’d.)

• Describe the structure and function of the arches of the foot; also, relate the windlass mechanism to the arches of the foot.
Joints of the Lower Extremity

- Symphysis pubis joint
- Sacroiliac joints
- Lumbosacral joint
- Hip joints
- Knee joint complex
- Tibiofibular joints
Joints of the Lower Extremity (cont’d.)

- Talocrural (ankle) joint
- Tarsal joints
- Tarsometatarsal joints
- Intermetatarsal joints
- Metatarsophalangeal (MTP) joints
- Interphalangeal (IP) joints
Section 8.17—Overview of the Ankle/Foot Region

- Transverse tarsal joint
- Navicular
- Cuneiforms
- Tarsometatarsal joints
- Metatarsals
- MTP (metatarsophalangeal) joints
- Phalanges
- Calcaneus
- Hindfoot
- Subtalar joint
- Cuboid
- Midfoot
- Forefoot
Regions of the Foot:

- Hindfoot
- Midfoot
- Forefoot
Functions of the Foot:

- Provides stability
  - Bears weight of body
  - Absorbs shock from motion
  - Propels body through space

- Provides flexibility
  - Adapts to uneven ground
Section 8.17—Overview of the Ankle/Foot Region (cont’d.)

Joints of the Ankle/Foot Region:
• Talocrural (ankle) joint
• Tarsal joints
  – Subtalar joint
  – Transverse tarsal joint
  – Distal intertarsal joints
Section 8.17—Overview of the Ankle/Foot Region (cont’d.)

Joints of the Ankle/Foot Region (cont’d.):

• Tarsometatarsal (TMT) joints
• Intermetatarsal joints
• Metatarsophalangeal (MTP) joints
• Interphalangeal (IP) joints
  – Proximal interphalangeal (PIP) joints
  – Distal interphalangeal (DIP) joints
Arches of the Foot:

- Medial longitudinal arch
- Lateral longitudinal arch
- Transverse arch
Section 8.17—Overview of the Ankle/Foot Region (cont’d.)

Evaluating the Arches of the Foot:

• Pes cavus (excessive arch)
• Pes planus (decreased arch)
Section 8.17—Overview of the Ankle/Foot Region (cont’d.)

Plantar Fascia:

• Superficial layer

• Deep layer
Windlass Mechanism:
Section 8.17—Overview of the Ankle/Foot Region (cont’d.)

- **Retinacula**
  - Hold down and stabilize tendons
- **Bowstringing**
  - The lifting of a tendon away from its joint when a muscle contracts
Lesson 8.5 Objective

• Define pronation and supination of the foot; list and explain the component cardinal plane actions of pronation and supination.
Joints of the Lower Extremity

- Symphysis pubis joint
- Sacroiliac joints
- Lumbosacral joint
- Hip joints
- Knee joint complex
- Tibiofibular joints
Joints of the Lower Extremity (cont’d.)

• Talocrural (ankle) joint
• Tarsal joints
• Tarsometatarsal joints
• Intermetatarsal joints
• Metatarsophalangeal (MTP) joints
• Interphalangeal (IP) joints
Section 8.18—Talocrural (Ankle) Joint

A

Ankle joint

B

Mortise joint analogy

C

Nut/wrench analogy
Section 8.18—Talocrural (Ankle) Joint (cont’d.)

Structure Classification:
• Synovial joint
  – Hinge joint

Function Classification:
• Diarthrotic
  – Uniaxial
Section 8.18—Talocrural (Ankle) Joint (cont’d.)

Major Motions Allowed:

• Dorsiflexion and plantarflexion of foot

Reverse Actions:

• Dorsiflexion and plantarflexion of leg
Section 8.18—Talocrural (Ankle) Joint (cont’d.)
Section 8.18—Talocrural (Ankle) Joint (cont’d.)

Average Ranges of Motion:

- Dorsiflexion: 20 degrees
- Plantarflexion: 50 degrees

* The amount of dorsiflexion varies based on the position of the knee joint.
Major Ligaments of the Ankle Joint:

- Fibrous joint capsule
- Medial collateral ligament
- Lateral collateral ligament complex
  - Anterior talofibular ligament
  - Posterior talofibular ligament
  - Calcaneofibular ligament
Section 8.18—Talocrural (Ankle) Joint (cont’d.)
Section 8.18—Talocrural (Ankle) Joint (cont’d.)
Section 8.18—Talocrural (Ankle) Joint (cont’d.)

Closed-Packed Position:

• Dorsiflexion

Major Muscles of the Ankle Joint:

• Anterior muscles
• Posterior muscles
• Medial muscles
• Lateral muscles
Section 8.18—Talocrural (Ankle) Joint (cont’d.)
Section 8.19—Subtalar Tarsal Joint

Lateral View:
Section 8.19—Subtalar Tarsal Joint (cont’d.)
Section 8.19—Subtalar Tarsal Joint (cont’d.)

Structure Classification:
• Synovial joint(s)

Function Classification:
• Diarthrotic
  – Uniaxial
Section 8.19—Subtalar Tarsal Joint (cont’d.)

Major Motions Allowed:

• Pronation and supination of foot

Reverse Actions:

• Medial rotation and lateral rotation of leg

Closed-Packed Position:

• Supination
Section 8.19—Subtalar Tarsal Joint (cont’d.)

A  Pronation

B  Supination
Section 8.19—Subtalar Tarsal Joint (cont’d.)

- Pronation
  - Eversion
  - Dorsiflexion
  - Abduction

- Supination
  - Inversion
  - Plantarflexion
  - Adduction
Section 8.19—Subtalar Tarsal Joint (cont’d.)

![Diagram of subtalar tarsal joint with arrows indicating eversion and inversion]
Section 8.19—Subtalar Tarsal Joint (cont’d.)

Dorsiflexion

Plantarflexion
Section 8.19—Subtalar Tarsal Joint (cont’d.)

Average Ranges of Motion:

- Eversion: 10 degrees
- Inversion: 20 degrees
- Dorsiflexion: 2.5 degrees
- Plantarflexion: 5 degrees
- Abduction: 10 degrees
- Adduction: 20 degrees
Section 8.19—Subtalar Tarsal Joint (cont’d.)

Major Ligaments of the Subtalar Joint:
- Fibrous joint capsule(s)
- Talocalcaneal ligaments
- Cervical ligament
- Spring ligament
Section 8.20—Transverse Tarsal Joint

Transverse tarsal joint

Calcaneocuboid joint

Talonavicular joint

Cuboid

Calcaneus

Navicular

Talus
Section 8.20—Transverse Tarsal Joint (cont’d.)

Compound Joint:

- Talonavicular joint
- Calcaneocuboid joint

Structure Classification:

- Synovial joint(s)
Section 8.20—Transverse Tarsal Joint (cont’d.)

Major Motions Allowed:
• Pronation and supination of foot

Closed-Packed Position:
• Supination
Section 8.20—Transverse Tarsal Joint (cont’d.)

Ligaments of the Transverse Tarsal Joint:

- Fibrous joint capsule(s)
- Spring ligament
- Long plantar ligament
- Short plantar ligament
- Dorsal calcaneocuboid ligament
- Bifurcate ligament
Lesson 8.6 Objective

• List the regions of the foot and the joints of the foot.
Joints of the Lower Extremity

- Symphysis pubis joint
- Sacroiliac joints
- Lumbosacral joint
- Hip joints
- Knee joint complex
- Tibiofibular joints
Joints of the Lower Extremity (cont’d.)

- Talocrural (ankle) joint
- Tarsal joints
- Tarsometatarsal joints
- Intermetatarsal joints
- Metatarsophalangeal (MTP) joints
- Interphalangeal (IP) joints
Section 8.21—
Tarsometatarsal Joints

![Diagram of tarsometatarsal joints with labels for various joints and bones, including 1st Metatarsal, 2nd TMT joint, 3rd TMT joint, 4th TMT joint, 5th TMT joint, Cuboid, 1st TMT joint, and Cuneiforms.]
Section 8.21—
Tarsometatarsal Joints
(cont’d.)

Major Motions Allowed:
• Dorsiflexion and plantarflexion of foot
• Inversion and eversion of foot

Ligaments of the Tarsometatarsal Joints
• Fibrous joint capsule
• Tarsometatarsal ligaments
Section 8.22—Intermetatarsal (IMT) Joints
Section 8.22—Intermetatarsal (IMT) Joints (cont’d.)

Collateral ligaments of MTP joints

Deep transverse metatarsal ligaments

Plantar intermetatarsal ligaments

Cuboid

Phalanges

Plantar plates of MTP joints

1st metatarsal

4th metatarsal

Calcaneus
Section 8.22—Intermetatarsal (IMT) Joints (cont’d.)

Major Motions Allowed:

• Nonaxial gliding motion of one metatarsal relative to the adjacent metatarsals
Section 8.23—Metatarsophalangeal Joints

![Diagram of the metatarsophalangeal joints showing the 2nd and 4th proximal phalanges and metatarsals.](image-url)
Section 8.23—
Metatarsophalangeal Joints (cont’d.)

Figure 8-45

A
B
Section 8.23—Metatarsophalangeal Joints (cont’d.)
Ligaments of the MTP Joints:
- Fibrous joint capsule
- Collateral ligaments
- Plantar plate

Closed-Packed Position:
- Extension
Section 8.23—Metatarsophalangeal Joints (cont’d.)

Phalanges
- Distal
- Middle
- Proximal

Capsule of MTP joint

Metatarsal

DIP joint

PIP joint

Collateral ligament

Plantar plate
Section 8.24—Interphalangeal Joints of the Foot

![Diagram of the foot showing interphalangeal joints](image)

- 5th PIP joint
- 5th DIP joint
- 3rd PIP joint
- 3rd DIP joint
- Distal phalanx
- Middle phalanx
- Proximal phalanx
- Distal phalanx
- IP joint
- Proximal phalanx
Major Motions Allowed:
• Flexion and extension of toes

Ligaments of the IP Joints of the Foot:
• Fibrous capsule
• Medial collateral ligament
• Lateral collateral ligament
• Plantar plate