This section reviews the structure and function of the major joints and their connecting bony structures, muscles, and soft tissues. To lay the foundation for skilled assessment of the musculoskeletal system, it is essential for you to learn both the surface landmarks and underlying anatomy of each of the major joints. Anatomy and Physiology follows a “head to toe” sequence, beginning with the jaw and joints of the upper extremities, then proceeding to the spine and hip and the joints of the lower extremities. For each joint there are subsections on Overview, Bony Structures and Joints, and Muscle Groups and Additional Structures. The Overview should help orient you to the distinguishing anatomic and functional features of each joint. As you study Anatomy and Physiology, practice identifying the important surface landmarks on yourself or a fellow student. Then turn to Techniques of Examination, also “head to toe,” to learn the fundamental steps for examining the joints—inspection; palpation of bony landmarks and soft-tissue structures; assessment of range of motion, or the directions of joint movement; and maneuvers to test joint function.

It is helpful to begin by reviewing some anatomic terminology. Articular structures include the joint capsule and articular cartilage, the synovium and synovial fluid, intra-articular ligaments, and juxta-articular bone. Nonarticualr structures include periarticular ligaments, tendons, bursae, muscle, fascia, bone, nerve, and overlying skin. You will need to visualize and assess all these structures to care for your patients with joint complaints. Note that ligaments are ropelike bundles of collagen fibrils that connect bone to bone. Tendons are collagen fibers connecting muscle to bone. Another type of collagen matrix forms the cartilage that overlies bony surfaces. Bursae are pouches of synovial fluid that cushion the movement of tendons and muscles over bone or other joint structures.

Structure and Function of Joints

To understand joint function, begin by reviewing the various types of joints and how they articulate, or interconnect, and the role of bursae in easing joint movement.
**Types of Joints.** There are three primary types of joint articulation—synovial, cartilaginous, and fibrous—allowing varying degrees of joint movement.

<table>
<thead>
<tr>
<th>Type of Joint</th>
<th>Extent of Movement</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Synovial</td>
<td>Freely movable</td>
<td>Knee, shoulder</td>
</tr>
<tr>
<td>Cartilaginous</td>
<td>Slightly movable</td>
<td>Vertebral bodies of the spine</td>
</tr>
<tr>
<td>Fibrous</td>
<td>Immovable</td>
<td>Skull sutures</td>
</tr>
</tbody>
</table>

In *synovial joints*, the bones do not touch each other, and the joint articulations are *freely movable*. The bones are covered by *articular cartilage* and separated by a *synovial cavity* that cushions joint movement, as shown. A *synovial membrane* lines the synovial cavity and secretes a small amount of viscous lubricating fluid—the *synovial fluid*. The membrane is attached at the margins of the articular cartilage and pouched or folded to accommodate joint movement. Surrounding the synovial membrane is a fibrous *joint capsule*, which is strengthened by ligaments extending from bone to bone.

*Cartilaginous joints*, such as those between vertebrae and the symphysis pubis, are *slightly movable*. Fibrocartilaginous discs separate the bony surfaces. At the center of each disc is the *nucleus pulposus*, fibrocartilaginous material that serves as a cushion or shock absorber between bony surfaces.

In *fibrous joints*, such as the sutures of the skull, intervening layers of fibrous tissue or cartilage hold the bones together. The bones are almost in direct contact, which allows *no appreciable movement*. 

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**ANATOMY AND PHYSIOLOGY**

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**FIBROUS**

**CARTILAGINOUS**

**SYNOVIAL**
As you learn about the examination of the musculoskeletal system, think about how the anatomy of the joint relates to its movement. Many of the joints we examine are synovial, or movable, joints. The shape of the articulating surfaces of synovial joints determines the type of motion in the joint. Spheroidal joints have a ball-and-socket configuration—a rounded convex surface articulating with a cuplike cavity, allowing a wide range of rotatory movement as in the shoulder and hip. Hinge joints are flat, planar, or slightly curved, allowing a gliding motion in one plane only, as in flexion and extension of the digits. In condylar joints, such as the knee, the articulating surfaces are convex or concave, and referred to as condyles.

<table>
<thead>
<tr>
<th>Synovial Joints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Joint</td>
</tr>
<tr>
<td>Spheroidal</td>
</tr>
<tr>
<td>(ball and</td>
</tr>
<tr>
<td>socket)</td>
</tr>
<tr>
<td>Hinge</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Condylar</td>
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</tbody>
</table>

**Bursae.** Easing joint action are bursae, roughly disc-shaped synovial sacs that allow adjacent muscles or muscles and tendons to glide over each other during movement. They lie between the skin and the convex surface of a bone or joint (as in the prepatellar bursa of the knee, p. 481) or in areas where tendons or muscles rub against bone, ligaments, or other tendons or muscles (as in the subacromial bursa of the shoulder, p. 472).

Knowledge of the underlying joint anatomy and movement will help you assess joints subjected to trauma. Your knowledge of the soft-tissue structures, ligaments, tendons, and bursae will help you evaluate the changes of aging, as well as arthritis.

**Temporomandibular Joint**

**Overview, Bony Structures, and Joints.** The temporomandibular joint is the most active joint in the body, opening and closing up to 2000 times a day. It is formed by the fossa and articular tubercle of the temporal
bone and the condyle of the mandible. It lies midway between the external acoustic meatus and the zygomatic arch.

A fibrocartilaginous disc cushions the action of the condyle of the mandible against the synovial membrane and capsule of the articulating surfaces of the temporal bone. Hence, it is a condylar synovial joint.

**Muscle Groups and Additional Structures.** The principal muscles opening the mouth are the external pterygoids. Closing the mouth are the muscles innervated by Cranial Nerve V, the trigeminal nerve (see p. 538)—the masseter, the temporalis, and the internal pterygoids.
The Shoulder

**Overview.** The shoulder is distinguished by wide-ranging movement in all directions. The humerus virtually dangles from the scapula, suspended from the shallow glenoid fossa by the joint capsule, the intra-articular capsular ligaments, the glenoid labrum, and a meshwork of muscles and tendons. The shoulder derives its mobility from a complex interconnected structure of four joints, three large bones, and three principal muscle groups, often referred to as the *shoulder girdle*. The clavicle and acromion stabilize the shoulder girdle, allowing the humerus to swing out and away from the body, giving the shoulder its remarkable range of motion.

**Bony Structures.** The bony structures of the shoulder include the humerus, the clavicle, and the scapula. The scapula is anchored to the axial skeleton only by the sternoclavicular joint and inserting muscles, often called the *scapulothoracic articulation* since it is not a true joint.

Identify the manubrium, the sternoclavicular joint, and the clavicle. With your fingers, trace the clavicle laterally. Now, from behind, follow the bony spine of the scapula laterally and upward until it becomes the *acromion*, the summit of the shoulder. Its upper surface is rough and slightly convex. Identify the anterior tip of the acromion (A) and mark it with ink. With your index finger on top of the acromion, just behind its tip, press medially to find...
the slightly elevated ridge that marks the distal end of the clavicle at the \textit{acromioclavicular joint} (shown by the arrow). Move your finger laterally and down a short step to the next bony prominence, the \textit{greater tubercle of the humerus} (B). Mark this with ink. Now sweep your finger medially until you feel a large bony prominence, the \textit{coracoid process} of the scapula (C). Mark this also. These three points—the tip of the acromion, the greater tubercle of the humerus, and the coracoid process—orient you to the anatomy of the shoulder.

\textbf{Joints.} Three different joints articulate at the shoulder:

- The \textit{glenohumeral joint}. In this joint, the head of the humerus articulates with the shallow glenoid fossa of the scapula. This joint is deeply situated and not normally palpable. It is a ball-and-socket joint, allowing the arm its wide arc of movement—flexion, extension, abduction (movement away from the trunk), adduction (movement toward the trunk), rotation, and circumduction.

- The \textit{sternoclavicular joint}. The convex medial end of the clavicle articulates with the concave hollow in the upper sternum.

- The \textit{acromioclavicular joint}. The lateral end of the clavicle articulates with the acromion process of the scapula.

\textbf{Muscle Groups.} Three groups of muscles attach at the shoulder:

\textbf{The Scapulohumeral Group.} This group extends from the scapula to the humerus and includes the muscles inserting directly on the humerus, known as \textit{“SITS muscles”} of the rotator cuff:

- \textit{Supraspinatus}—runs above the glenohumeral joint; inserts on the greater tubercle

- \textit{Infraspinatus} and \textit{teres minor}—cross the glenohumeral joint posteriorly; insert on the greater tubercle

- \textit{Subscapularis} (not illustrated)—originates on the anterior surface of the scapula and crosses the joint anteriorly; inserts on the lesser tubercle.
The scapulohumeral group rotates the shoulder laterally (the rotator cuff) and depresses and rotates the head of the humerus. (See pp. 526–527 for discussion of rotator cuff injuries.)

The Axioscapular Group. This group attaches the trunk to the scapula and includes the trapezius, rhomboids, serratus anterior, and levator scapulæ. These muscles rotate the scapula.

The Axiohumeral Group. This group attaches the trunk to the humerus and includes the pectoralis major and minor and the latissimus dorsi. These muscles produce internal rotation of the shoulder.

The biceps and triceps, which connect the scapula to the bones of the forearm, are also involved in shoulder movement, particularly abduction.

Additional Structures. Also important to shoulder movement are the articular capsule and bursae. Surrounding the glenohumeral joint is a fibrous articular capsule formed by the tendon insertions of the rotator cuff and other capsular muscles. The loose fit of the capsule allows the shoulder bones to separate, and contributes to the shoulder’s wide range of movement. The capsule is lined by a synovial membrane with two outpouchings—the subscapular bursa and the synovial sheath of the tendon of the long head of the biceps.

To locate the biceps tendon, rotate the arm externally and find the tendinous cord that runs just medial to the greater tubercle. Roll it under your fingers. This is the tendon of the long head of the biceps. It runs in the bicipital groove between the greater and lesser tubercles.

The principal bursa of the shoulder is the subacromial bursa, positioned between the acromion and the head of the humerus and overlying the supraspinatus tendon. Abduction of the shoulder compresses this bursa. Normally, the supraspinatus tendon and the subacromial bursa are not palpable. However, if the bursal surfaces are inflamed (subacromial bursitis), there may be tenderness just below the tip of the acromion, pain with abduction and rotation, and loss of smooth movement.

The Elbow

Overview, Bony Structures, and Joints. The elbow helps position the hand in space and stabilizes the lever action of the forearm. The elbow
The joint is formed by the humerus and the two bones of the forearm, the radius and the ulna. Identify the medial and lateral epicondyles of the humerus and the olecranon process of the ulna.

These bones have three articulations: the humeroulnar joint, the radiohumeral joint, and the radioulnar joint. All three share a large common articular cavity and an extensive synovial lining.

**Muscle Groups and Additional Structures.** Muscles traversing the elbow include the biceps and brachioradialis (flexion), the triceps (extension), the pronator teres (pronation), and the supinator (supination).
Note the location of the olecranon bursa between the olecranon process and the skin. The bursa is not normally palpable but swells and becomes tender when inflamed. The ulnar nerve runs posteriorly between the medial epicondyle and the olecranon process. On the ventral forearm, the median nerve is just medial to the brachial artery.

**The Wrist and Hands**

**Overview.** The wrist and hands form a complex unit of small, highly active joints used almost continuously during waking hours. There is little protection from overlying soft tissue, increasing vulnerability to trauma and disability.

**Bony Structures.** The wrist includes the distal radius and ulna and eight small carpal bones. At the wrist, identify the bony tips of the radius and the ulna.

The carpal bones lie distal to the wrist joint within each hand. Identify the carpal bones, each of the five metacarpals, and the proximal, middle, and distal phalanges. Note that the thumb lacks a middle phalanx.

**Joints.** The numerous joints of the wrist and hand lend unusual dexterity to the hands.

- **Wrist joints.** The wrist joints include the radiocarpal or wrist joint, the distal radioulnar joint, and the intercarpal joints. The joint capsule, articular disc, and synovial membrane of the wrist join the radius to the ulna and to the proximal carpal bones. On the dorsum of the wrist, locate the groove of the radiocarpal joint.
Hand joints. The joints of the hand include the metacarpophalangeal joints (MCPs), the proximal interphalangeal joints (PIPs), and the distal interphalangeal joints (DIPs). Flex the hand and find the groove marking the MCP joint of each finger. It is distal to the knuckle and is best felt on either side of the extensor tendon.

Muscle Groups. Wrist flexion arises from the two carpal muscles, located on the radial and ulnar surfaces. Two radial and one ulnar muscle provide wrist extension. Supination and pronation result from muscle contraction in the forearm.

The thumb is powered by three muscles that form the thenar eminence and provide flexion, abduction, and opposition. The muscles of extension are at the base of the thumb along the radial margin. Movement in the digits depends on action of the flexor and extensor tendons of muscles in the forearm and wrist.

The intrinsic muscles of the hand attaching to the metacarpal bones are involved in flexion (lumbricals), abduction (dorsal interossei), and adduction (palmar interossei) of the fingers.

Additional Structures. Soft-tissue structures, especially tendons and tendon sheaths, are extremely important in the wrist and hand. Six extensor tendons and two flexor tendons pass across the wrist and hand to insert on the fingers. Through much of their course these tendons travel in tunnel-like sheaths, generally palpable only when swollen or inflamed.

Be familiar with the structures in the carpal tunnel, a channel beneath the palmar surface of the wrist and proximal hand. The canal contains the sheath and flexor tendons of the forearm muscles and the median nerve.

Holding the tendons and tendon sheath in place is a transverse ligament, the flexor retinaculum. The median nerve lies between the flexor retinaculum and the tendon sheath. It provides sensation to the palm and the palmar surface of most of the thumb, the second and third digits, and half of the fourth digit. It also innervates the thumb muscles of flexion, abduction, and opposition.
The Spine

Overview. The vertebral column, or spine, is the central supporting structure of the trunk and back. Note the *concave curves* of the cervical and lumbar spine and the *convex curves* of the thoracic and sacroccygeal spine. These curves help distribute upper body weight to the pelvis and lower extremities and cushion the concussive impact of walking or running.

The complex mechanics of the back reflect the coordinated action of:

- The vertebrae and intervertebral discs

- An interconnecting system of ligaments between anterior vertebrae and posterior vertebrae, ligaments between the spinous processes, and ligaments between the lamina of two adjacent vertebrae

- Large superficial muscles, deeper intrinsic muscles, and muscles of the abdominal wall.

Viewing the patient from behind, identify the following landmarks:

1. Spinous processes, usually more prominent at C7 and T1 and more evident on forward flexion

2. Paravertebral muscles on either side of the midline

3. Scapulae

4. Iliac crests

5. Posterior superior iliac spines, usually marked by skin dimples.

A line drawn above the posterior iliac crests crosses the spinous process of L4.
Bony Structures. The vertebral column contains 24 vertebrae stacked on the sacrum and coccyx. A typical vertebra contains sites for joint articulations, weight bearing, and muscle attachments, as well as foramina for the spinal nerve roots and peripheral nerves. Anteriorly, the vertebral body supports weight bearing. The posterior vertebral arch encloses the spinal cord. Review the location of the vertebral processes and foramina, with particular attention to:

- The spinous process projecting posteriorly in the midline and the two transverse processes at the junction of the pedicle and the lamina. Muscles attach at these processes.
- The articular processes—two on each side of the vertebra, one facing up and one facing down, at the junction of the pedicles and laminae, often called articular facets.
- The vertebral foramen, which encloses the spinal cord, the intervertebral foramen, formed by the inferior and superior articulating process of adjacent vertebrae, creating a channel for the spinal nerve roots; and in the cervical vertebrae, the transverse foramen for the vertebral artery.

The proximity of the spinal cord and spinal nerve roots to their bony vertebral casing and the intervertebral discs makes them especially vulnerable to disc herniation, impingement from degenerative changes in the vertebrae, and trauma.

Joints. The spine has slightly movable cartilaginous joints between the vertebral bodies and between the articular facets. Between the vertebral bodies are the intervertebral discs, each consisting
of a soft mucoid central core, the *nucleus pulposus*, rimmed by the tough fibrous tissue of the *annulus fibrosis*. The intervertebral discs cushion movement between vertebrae and allow the vertebral column to curve, flex, and bend. The flexibility of the spine is largely determined by the angle of the articular facet joints relative to the plane of the vertebral body, and varies at different levels of the spine. Note that the vertebral column angles sharply posterior at the *lumbosacral junction* and becomes immovable. The mechanical stress at this angulation contributes to the risk of disc herniation and subluxation, or slippage, of L5 on S1.

**Muscle Groups.** The *trapezius* and *latissimus dorsi* form the large outer layer of muscles attaching to each side of the spine. They overlie two deeper muscle layers—a layer attaching to the head, neck, and spinous processes (*splenius capitis, splenius cervicis, and sacrospinalis*) and a layer of smaller intrinsic muscles between vertebrae. Muscles attaching to the anterior surface of the vertebrae, including the *psoas* muscle and muscles of the abdominal wall, assist with flexion.

Muscles moving the neck and lower vertebral column are summarized below.

<table>
<thead>
<tr>
<th>Movement</th>
<th>Principal Muscle Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cervical Spine (neck)</td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>Sternocleidomastoid, scalene, and prevertebral muscles</td>
</tr>
<tr>
<td>Extension</td>
<td>Splenius, trapezius, small intrinsic neck muscles</td>
</tr>
<tr>
<td>Rotation</td>
<td>Sternocleidomastoid, small intrinsic neck muscles</td>
</tr>
<tr>
<td>Lateral bending</td>
<td>Scalen e and small intrinsic neck muscles</td>
</tr>
<tr>
<td>Lumbar Spine</td>
<td></td>
</tr>
<tr>
<td>Flexion</td>
<td>Psoas major, psoas minor, quadratus lumborum; abdominal muscles such as the internal and external obliques and rectus abdominis, attaching to the anterior vertebrae</td>
</tr>
<tr>
<td>Extension</td>
<td>Intrinsic muscles of the back, sacrospinalis</td>
</tr>
<tr>
<td>Rotation</td>
<td>Abdominal muscles, intrinsic muscles of the back</td>
</tr>
<tr>
<td>Lateral bending</td>
<td>Abdominal muscles, intrinsic muscles of the back</td>
</tr>
</tbody>
</table>
**The Hip**

**Overview.** The hip joint is deeply embedded in the pelvis, and is notable for its strength, stability, and wide range of motion. The stability of the hip joint, so essential for weight bearing, arises from the deep fit of the head of the femur into the acetabulum, its strong fibrous articular capsule, and the powerful muscles crossing the joint and inserting below the femoral head, providing leverage for movement of the femur.

**Bony Structures and Joints.** The hip joint lies below the middle third of the inguinal ligament but in a deeper plane. It is a ball-and-socket joint—note how the rounded head of the femur articulates with the cuplike cavity of the acetabulum. Because of its overlying muscles and depth, it is not readily palpable. Review the bones of the pelvis—the acetabulum, the ilium, and the ischium—and the connection inferiorly at the symphysis pubis and posteriorly with the sacroiliac bone.

On the *anterior aspect* of the hip, identify the *iliac crest* at the upper margin of the pelvis at the level of L4. Follow the downward anterior curve and locate the *iliac tubercle*, marking the widest point of the crest, and continue tracking downward to the *anterior superior iliac spine*. Place your thumbs on the anterior superior spines and move your fingers downward from the iliac tubercles to the *greater trochanter* of the femur. Then move your thumbs medially and obliquely to the *pubic symphysis*, which lies at the same level as the greater trochanter.

On the *posterior aspect* of the hip, locate the *posterior superior iliac spine* directly underneath the visible dimples just above the buttocks. Placing your left thumb and index finger over the posterior superior iliac spine, next locate the *greater trochanter* laterally with your fingers at the level of the gluteal fold and place your thumb medially on the *ischial tuberosity*. The *sacroiliac joint* is not palpable. Note that an imaginary line between the posterior superior iliac spines crosses the joint at S2.
Muscle Groups. Four powerful muscle groups move the hip. To remember these groups, try to picture where muscles need to cross joints to move limbs such as the femur in a given direction. The flexor group lies anteriorly and flexes the thigh. The primary hip flexor is the iliopsoas, extending from above the iliac crest to the lesser trochanter. The extensor group lies posteriorly and extends the thigh. The gluteus maximus is the primary extensor of the hip. It forms a band crossing from its origin along the medial pelvis to its insertion below the trochanter.

The adductor group is medial and swings the thigh toward the body. The muscles in this group arise from the rami of the pubis and ischium and insert on the posteromedial aspect of the femur. The abductor group is lateral, extending from the iliac crest to the head of the femur, and moves the thigh away from the body. This group includes the gluteus medius and minimus. These muscles help stabilize the pelvis during the stance phase of gait.

Additional Structures. A strong dense articular capsule, extending from the acetabulum to the femoral neck, encases and strengthens the hip joint, reinforced by three overlying ligaments and lined with synovial membrane. There are three principal bursae at the hip. Anterior to the joint is the iliopsoas (or iliopsoas) bursa, overlying the articular capsule and the psoas muscle. Find the bony prominence lateral to the hip joint—the greater trochanter of the femur. The large multilocular trochanteric bursa lies on its posterior surface. The ischiogluteal bursa—not always present—lies under the ischial tuberosity, on which a person sits. Note their proximity to the sciatic nerve, as shown on p. 475.

The Knee

Overview. The knee joint is the largest joint in the body. It involves three bones: the femur, the tibia, and the patella (or knee cap), with three articular surfaces, two between the femur and the tibia and one between the femur
and the patella. Note how the two rounded condyles of the femur rest on the relatively flat tibial plateau. There is no inherent stability in the knee joint itself, making it dependent on ligaments to hold its articulating bones in place. This feature, in addition to the lever action of the femur on the tibia and lack of padding from fat or muscle, makes the knee highly vulnerable to injury.

**Bony Structures.** Landmarks in and around the knee will orient you to this complicated joint. Bring your fingertips firmly down the medial surface of the thigh along a line analogous to the inner seam of a pant leg. Your fingers will run up against an abrupt bony prominence, the *adductor tubercle*. Just below this is the *medial epicondyle*. The *lateral epicondyle* is comparably situated on the other side.

Identify the flat medial surface of the tibia—the shin. Follow its anterior border upward to the *tibial tuberosity* (A). Mark this point with a dot of ink. Now follow the medial border of the tibia upward until it merges into a bony prominence—the *medial condyle of the tibia* (B). This is somewhat higher than the tibial tuberosity. In a comparable location on the other side of the knee, find a similar prominence—the *lateral condyle* (C). Mark both condyles with ink. These three points form an isosceles triangle. On the lateral surface of the knee, somewhat below the level of the lateral tibial condyle, find the head of the fibula.

The *patella* rests on the anterior articulating surface of the femur, midway between the epicondyles, embedded in the tendon of the quadriceps muscle. This tendon continues below the knee joint as the *patellar tendon* and inserts on the tibial tuberosity.
Joints. Two condylar tibiofemoral joints are formed by the convex curves of the medial and lateral condyles of the femur as they articulate with the concave condyles of the tibia. The third articular surface is the patellofemoral joint. The patella slides in a groove on the anterior aspect of the distal femur, called the trochlear groove, during flexion and extension of the knee.

With the knee flexed about 90°, you can press your thumbs—one on each side of the patellar tendon—into the groove of the tibiofemoral joint. Note that the patella lies just above this joint line. As you press your thumbs downward, you can feel the edge of the tibial plateau, the upper surface of the tibia. Follow it medially, then laterally until you are stopped by the converging femur and tibia. By moving your thumbs upward toward the midline to the top of the patella, you can follow the articulating surface of the femur and identify the margins of the joint.

Muscle Groups. Powerful muscles move and support the knee. The quadriceps femoris extends the leg, covering the anterior, medial, and lateral aspects of the thigh. The hamstring muscles lie on the posterior aspect of the thigh and flex the knee.
Additional Structures. Two important pairs of ligaments, the collateral ligaments and the cruciate ligaments, and the menisci provide stability to the knee (see drawing on pp. 480 and 481).

- The **medial collateral ligament** (MCL), not easily palpable, is a broad flat ligament connecting the medial condyles of the femur and the tibia. To locate the anatomic region of the MCL, move your fingers medially and posteriorly along the joint line, then palpate along the ligament from its origin to insertion.

- The **lateral collateral ligament** (LCL) connects the lateral femoral condyle and the head of the fibula. To feel the LCL, cross one leg so the ankle rests on the opposite knee and find the firm cord that runs from the lateral epicondyle of the femur to the head of the fibula. The MCL and LCL provide medial and lateral stability to the knee.

- The **anterior cruciate ligament** (ACL) crosses obliquely from the lateral femoral condyle to the medial tibia, preventing the tibia from sliding forward on the femur.

- The **posterior cruciate ligament** (PCL) crosses from the lateral tibia and lateral meniscus to the medial femoral condyle, preventing the tibia from slipping backward on the femur. Since these ligaments lie within the knee joint, they are not palpable. They are nonetheless crucial to the antero-posterior stability of the knee.

- The **medial and lateral menisci** cushion the action of the femur on the tibia. These crescent-shaped fibrocartilaginous discs add a cuplike surface to the otherwise flat tibial plateau. Palpate the **medial meniscus** by pressing on the medial soft-tissue depression along the upper edge of the tibial plateau. Place the knee in slight flexion and palpate the **lateral meniscus** along the lateral joint line.

Observe the concavities that are usually evident at each side of the patella and also above it. Occupying these areas is the synovial cavity of the knee, the largest joint cavity in the body. This cavity includes an extension 6 centimeters above the upper border of the patella, lying upward and deep to the quadriceps muscle—the **suprapatellar pouch**. The joint cavity covers the anterior, medial, and lateral surfaces of the knee, as well as the condyles of the femur and tibia posteriorly. Although the synovium is not normally detectable, these areas may become swollen and tender when the joint is inflamed.

Several bursae lie near the knee. The **prepatellar bursa** lies between the patella and the overlying skin. The **anserine bursa** lies 1 to 2 inches below the knee joint on the medial surface and cannot be palpated due to overlying tendons. Now identify the large **semimembranosus bursa** that communicates with the joint cavity, also on the posterior and medial surfaces of the knee.
The Ankle and Foot

Overview. The total weight of the body is transmitted through the ankle to the foot. The ankle and foot must balance the body and absorb the impact of the heel strike and gait. Despite thick padding along the toes, sole, and heel and stabilizing ligaments at the ankles, the ankle and foot are frequent sites of sprain and bony injury.

Bony Structures and Joints. The ankle is a hinge joint formed by the tibia, the fibula, and the talus. The tibia and fibula act as a mortise, stabilizing the joint while bracing the talus like an inverted cup.

The principal joints of the ankle are the tibiotalar joint, between the tibia and the talus, and the subtalar (talocalcaneal) joint.

Note the principal landmarks of the ankle: the medial malleolus, the bony prominence at the distal end of the tibia, and the lateral malleolus, at the distal end of the fibula. Lodged under the talus and jutting posteriorly is the calcaneus, or heel.

An imaginary line, the longitudinal arch, spans the foot, extending from the calcaneus of the hind foot along the tarsal bones of the midfoot (see cuneiforms, navicular, and cuboid bones below) to the forefoot metatarsals and toes. The heads of the metatarsals are palpable in the ball of the foot. In the forefoot, identify the metatarsophalangeal joints, proximal to the webs of the toes, and the proximal and distal interphalangeal joints of the toes.

Muscle Groups and Additional Structures. Movement at the ankle joint is limited to dorsiflexion and plantar flexion. Plantar flexion is powered by the gastrocnemius, the posterior tibial muscle, and the toe flexors. Their tendons run behind the malleoli. The dorsiflexors include the anterior tibial muscle and the toe extensors. They lie prominently on the anterior surface, or dorsum, of the ankle, anterior to the malleoli.

Ligaments extend from each malleolus onto the foot. Medially, the triangle-shaped deltoid ligament fans out between the malleoli.
out from the inferior surface of the medial malleolus to the talus and proximal tarsal bones, protecting against stress from eversion (ankle bows inward). The three ligaments on the lateral side are less substantial, with higher risk of injury: the *anterior talofibular ligament*—most at risk in injury from inversion (ankle bows outward) injuries; the *calcaneofibular ligament*; and the *posterior talofibular ligament*. The strong Achilles tendon inserts on the heel posteriorly.

### Changes With Aging

Musculoskeletal changes continue through the adult years. Soon after maturity adults begin to lose height subtly, and significant shortening becomes obvious in old age. Most loss of height occurs in the trunk as intervertebral discs become thinner and the vertebral bodies shorten or even collapse because of osteoporosis. Flexion at the knees and hips may contribute to shortened stature. The limbs of an elderly person thus tend to look long in proportion to the trunk.

The alterations in discs and vertebrae contribute too to the kyphosis of aging and increase the anteroposterior diameter of the chest, especially in women.

With aging, skeletal muscles decrease in bulk and power, and ligaments lose some of their tensile strength. Range of motion diminishes, partly because of osteoarthritis.

### THE HEALTH HISTORY

#### Common or Concerning Symptoms

- Low back pain
- Neck pain
- Monoarticular or polyarticular joint pain
- Inflammatory or infectious joint pain
- Joint pain with systemic features such as fever, chills, rash, anorexia, weight loss, weakness
- Joint pain with symptoms from other organ systems

*Joint pain* is a common complaint of patients seeking health care. The health history is especially important in guiding you to the correct assessment.

You may wish to begin with “Any pains in your back?” since backache is the most common and widespread disorder of the musculoskeletal system. Using your usual interviewing style, get a clear picture of the problem, especially its

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See Table 15-1, Low Back Pain, p. 522.
location. Establish whether the pain is on midline, in the area of the vertebrae, or off the midline. If the pain radiates into the legs, ask about any associated numbness, tingling, or weakness.

Neck pain is also common, especially after trauma. Approach it in the same manner. For both neck and back pain, be especially alert for symptoms such as weakness, loss of sensation, or loss of bladder or bowel function.

To pursue other musculoskeletal disorders, ask “Do you have any pains in your joints?” If yes, you will need to determine whether the pain is localized or widespread, acute or chronic, inflammatory or noninflammatory.

Joint pain may be localized, diffuse, or systemic. Ask the patient to point to the pain. If the joint pain is localized and involves only one joint, it is monoarticular. Pain originating in the small joints of the hands and feet is more sharply localized than that from the larger joints. Pain from the hip joint is especially deceptive. Although it is typically felt in the groin or buttock, it is sometimes felt in the anterior thigh or partly or solely in the knee.

More diffuse joint pain may be polyarticular, involving several joints. Ask whether the pain involves one joint or several joints. If polyarticular, what is the pattern of involvement . . . migrating from joint to joint or steadily spreading from one joint to multiple joint involvement? Is the involvement symmetric, affecting similar joints on both sides of the body?

Note that joint pain may also be nonarticular, involving bones, muscles, and tissues around the joint such as the tendons, bursae, or even overlying skin. Generalized “aches and pains” are called myalgias if in muscles and arthralgias if there is pain but no evidence of arthritis.

Assess the timing, quality, and severity of the joint symptoms. Timing is especially important. Did the pain or discomfort develop rapidly over the course of a few hours or insidiously over weeks or even months? Has the pain progressed slowly or fluctuated, with periods of improvement and worsening? How long has the pain lasted? What is it like over the course of a day? . . . In the morning? . . . As the day wears on?

If more rapid in onset, how did the pain arise? Was there an acute injury or overuse from repetitive motion of the same part of the body? If the pain comes from trauma, what was the mechanism of injury or the series of events that caused the joint pain? Further, what aggravates or relieves the pain? What are the effects of exercise, rest, and treatment?

Examples of Abnormalities

Causes of midline back pain include musculoskeletal strain, vertebral collapse, disc herniation, or spinal cord metastases. Pain off the midline may arise from sacroiliitis, trochanteric bursitis, sciatica, or arthritis in the hips.

See Table 15-2, Pains in the Neck, p. 523.

Motor or sensory deficits, loss of bladder or bowel function in spinal cord compression at S2–S4

Pain in one joint suggests trauma, monoarticular arthritis, possible tendinitis, or bursitis. Hip pain near the greater trochanter suggests trochanteric bursitis.

Migratory pattern of spread in rheumatic fever or gonococcal arthritis; progressive additive pattern with symmetric involvement typically in rheumatoid arthritis

Problems in tissues around joints include inflammation of bursae (bursitis), tendons (tendinitis), or tendon sheaths (tenosynovitis); also sprains from stretching or tearing of ligaments

Severe pain of rapid onset in a swollen joint in the absence of trauma seen in acute septic arthritis or gout. In children consider osteomyelitis in bone contiguous to a joint.

See Table 15-3, Patterns of Pain In and Around the Joints, pp. 524–525.
Try to determine if the problem is inflammatory or noninflammatory. Is there tenderness, warmth, or redness? These features are best assessed on examination, but patients can sometimes guide you to points of tenderness. Ask about systemic symptoms such as fever or chills.

Additional symptoms can help you decide if the pain is articular in origin, such as swelling, stiffness, or decreased range of motion. Localize any swelling as accurately as possible. If stiffness is present, it may be difficult to assess because people use the term differently. In the context of musculoskeletal problems, stiffness refers to a perceived tightness or resistance to movement, the opposite of feeling limber. It is often associated with discomfort or pain. If the patient does not report stiffness spontaneously, ask about it and try to calculate its duration. Find out when the patient gets up in the morning and when the joints feel the most limber. Healthy people experience stiffness and muscular soreness after unusually strenuous muscular exertion; such symptoms tend to peak around the second day after exertion.

To assess limitations of motion, ask about changes in level of activity because of problems with the involved joint. When relevant, inquire specifically about the patient’s ability to walk, stand, lean over, sit up, rise from a sitting position, climb, pinch, grasp, turn a page, open a door handle or jar, and care for bodily needs such as combing hair, brushing teeth, eating, dressing, and bathing.

Finally, some joint problems have systemic features such as fever, chills, rash, anorexia, weight loss, and weakness.

Other joint disorders may be linked to organ systems outside the musculoskeletal system. Symptoms elsewhere in the body can give important clues to these conditions. Be alert to such symptoms as:

- **Skin conditions**

  A butterfly rash on the cheeks

  The scaly rash and pitted nails of psoriasis

  A few papules, pustules, or vesicles on reddened bases, located on the distal extremities

  An expanding erythematous patch early in an illness

  Hives

  Erosions or scale on the penis and crusted scaling papules on the soles and palms

- **Systemic lupus erythematosus**

- **Psoriatic arthritis**

- **Gonococcal arthritis**

- **Lyme disease**

- **Serum sickness, drug reaction**

- **Reiter’s syndrome, which also includes arthritis, urethritis, and ureitis**

- **Fever, chills, warmth, redness in septic arthritis; also consider gout or possible rheumatic fever**

- **Pain, swelling, loss of active and passive motion, “locking,” deformity in articular joint pain; loss of active but not passive motion, tenderness outside the joint, absence of deformity often in nonarticular pain**

- **Stiffness and limited motion after inactivity, sometimes called gelling, in degenerative joint disease but usually lasts only a few minutes; stiffness lasting ≥30 minutes in rheumatoid arthritis and other inflammatory arthritides. Stiffness also with fibromyalgia and polymyalgia rheumatica (PMR)**

- **Generalized symptoms are common in rheumatoid arthritis, systemic lupus erythematosus (SLE), PMR, and other inflammatory arthritides. High fever and chills suggest an infectious cause.**
The maculopapular rash of rubella

Clubbing of the fingernails (see p. 110)

- Red, burning, and itchy eyes (*conjunctivitis*)

- Preceding *sore throat*

- *Diarrhea, abdominal pain, cramping*

- Symptoms of *urethritis*

- Mental status change, facial or other weakness, stiff neck.

**HEALTH PROMOTION AND COUNSELING**

**Important Topics for Health Promotion and Counseling**

- Balanced nutrition, exercise, appropriate weight
- Lifting and the biomechanics of the back
- Risk factor screening and prevention of falls
- Counseling about prevention and treatment of osteoporosis

Maintaining the integrity of the musculoskeletal system brings many features of daily life into play—balanced nutrition, regular exercise, appropriate weight. As shown in this chapter, each joint has its specific vulnerabilities to trauma and wear. Care with lifting, avoidance of falls, household safety measures, and, for selected postmenopausal women, hormone replacement therapy help to protect and preserve well-functioning muscles and joints.

The habits of a healthy lifestyle convey direct benefit to the skeleton. Good nutrition supplies calcium needed for bone mineralization and bone density. Exercise appears to maintain and possibly increase bone mass, in addition to improving outlook and management of stress. Weight appropriate to height and body frame reduces excess mechanical wear on weight-bearing joints such as hips and knees. (For further discussion of these topics, see pp. 59–62.)

One of the most vulnerable parts of the skeleton is the low back, especially L5–S1, where the sacral vertebrae make a sharp posterior angle. More than 80% of the population experiences low back pain at least once in a lifetime. Usually symptoms are short lived, but there is a pattern of recurrence in 30%

**EXAMPLES OF ABNORMALITIES**

- Arthritis of rubella
- Hypertrophic osteoarthropathy
- Reiter’s syndrome, Behçet’s syndrome
- Acute rheumatic fever or gonococcal arthritis
- Arthritis with ulcerative colitis, regional enteritis, scleroderma
- Reiter’s syndrome or possibly gonococcal arthritis
- Lyme disease with central nervous system involvement
to 60% of individuals when onset is work related. Exercises to strengthen the low back, especially in flexion and extension, are often recommended (although studies have not consistently demonstrated a reduction in sick days from work). Alternatively, general fitness exercises appear equally effective. Education on lifting strategies, posture, and the biomechanics of injury is prudent for patients doing repetitive lifting such as nurses, heavy-machinery operators, and construction workers.

Among elderly persons in the United States, falls exact a heavy toll in morbidity and mortality. They are the leading cause of nonfatal injuries and account for a dramatic rise in death rates after age 65, increasing from ~5/100,000 in the general population to ~10/100,000 between the ages of 65 and 74 to ~147/100,000 after age 85.* Approximately 5% of falls result in fractures, usually of the wrist, hip, pelvis, or femur. Risk factors are both cognitive and physiological, including unstable gait, imbalanced posture, reduced strength, cognitive loss as in dementia, deficits in vision and proprioception, and osteoporosis. Poor lighting, stairs, chairs at awkward heights, slippery or irregular surfaces, and ill-fitting shoes are environmental dangers that can often be corrected. Clinicians should work with patients and families to help modify such risks whenever possible. Medications affecting balance, especially benzodiazepines, vasodilators, and diuretics, should be scrutinized. Home health assessments have proven useful in reducing environmental hazards, as have exercise programs to improve patient balance and strength.

Finally, it is important to counsel selected postmenopausal women about hormone replacement therapy and osteoporosis, defined as bone density >2.5 standard deviations below normal bone mass in young women.† Bone density reflects the interaction between bone mass (highest in the second decade), new bone formation, and bone resorption. A 10% drop in bone mineral density, equivalent to one standard deviation, is associated with a 20% increase in risk of fracture. Most fractures in patients over age 45 are attributable to postmenopausal osteoporosis. The decline in bone mass begins in the third decade and then accelerates in early menopause, especially in the trabecular bone of the vertebrae. At highest risk are women of Caucasian origin, slender build, or prior history of bilateral oophorectomy before menopause.

A number of agents inhibit bone resorption—calcium, vitamin D, calcitonin, bisphosphonates, and estrogen—but consensus on several clinical management decisions has yet to emerge. Criteria are unclear for identifying those women at menopause at greatest risk of bone loss and fractures one to two decades later. In addition, guidelines for tailoring dosage of medication to level of bone density have yet to be determined. Estrogen therapy appears to prevent vertebral trabecular bone resorption, and is most beneficial when started near menopause. Lifetime use is recommended because bone loss

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resumes once therapy is discontinued. Although hormone replacement pro-
tects against osteoporosis and possibly cardiovascular disease, use of estro-
gen must be weighed carefully in each patient against risk of breast cancer, 
endometrial cancer (risk is decreased by progesterone), and thrombosis. 
Cognitive, environmental, and other physiologic risk factors for falls and 
fractures should also be addressed.

**EXAMPLES OF ABNORMALITIES**

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**Preview: Recording the Examination—**

**The Musculoskeletal System**

The examples below contain phrases appropriate for most write-ups. 
Unfamiliar terms are explained in the next section, *Techniques of Examination*. 
Note that use of the anatomic terms specific to the structure and function of 
individual joint problems makes your write-up of musculoskeletal findings 
more meaningful and informative.

“Good range of motion in all joints. No evidence of swelling or 
deformity.”

**OR**

“Good range of motion in all joints. Hand with degenerative changes of 
Heberden’s nodes at the distal interphalangeal joints, Bouchard’s nodes 
at proximal interphalangeal joints. Mild pain with flexion, extension, 
and rotation of both hips. Good range of motion in the knees, with 
moderate crepitus; no effusion but boggy synovium and osteophytes 
along the tibiofemoral joint line bilaterally. Both feet with hallux valgus 
at the first metatarsophalangeal joints.”

**OR**

“Right knee with moderate effusion and tenderness over medial meniscus 
along the joint line. Moderate laxity of anterior cruciate ligament (ACL) 
on anterior drawer test; posterior cruciate ligament (PCL) and medial 
and lateral collateral ligaments (MCL, LCL) intact—no posterior drawer 
sign or tenderness with varus or valgus stress. Patellar tendon intact— 
patient able to extend lower extremity. All other joints with good range 
of motion, no other deformity or swelling.”

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*Suggests osteoarthritis*

*Suggests partial tear of medial meniscus and ACL, possibly from 
sports injury or trauma*
As you examine the musculoskeletal system, direct your attention to function as well as structure. During the interview you have evaluated the patient’s ability to carry out normal activities of daily living. Keep these abilities in mind during your physical examination.

In your initial survey of the patient you have assessed general appearance, body proportions, and ease of movement. Now, as you apply techniques of examination to the musculoskeletal system, visualize the underlying anatomy and recall the key elements of the history—for example, the mechanism of injury if there is trauma, or the time course of symptoms and limitations in function in arthritis.

Your examination should be systematic. It should include inspection, palpation of bony landmarks as well as related joint and soft-tissue structures, assessment of range of motion, and special maneuvers to test specific movements. These steps are described for each of the major joints. Recall that the anatomic shape of each joint determines its range of motion. This range is greatest in synovial or ball-and-socket joints.

Remember the following clues to guide your examination.

- During inspection, it is especially important to note symmetry of involvement. Is there a symmetric change in joints on both sides of the body, or is the change only in one or two joints?

- Also note any joint deformities or malalignment of bones.

- Use inspection and palpation to assess the surrounding tissues, noting skin changes, subcutaneous nodules, and muscle atrophy. Note any crepitus, an audible and/or palpable crunching during movement of tendons or ligaments over bone. This may occur in normal joints but is more significant when associated with symptoms or signs.

Acute involvement of only one joint suggests trauma, septic arthritis, gout. Rheumatoid arthritis typically involves several joints, symmetrically distributed.

Dupuytren’s contracture (p. 531), bowlegs or knock-knees (p. 779)

Subcutaneous nodules in rheumatoid arthritis or rheumatic fever; effusions in trauma; crepitus over inflamed joints, in osteoarthritis, or inflamed tendon sheaths
Decreased range of motion in arthritis, inflammation of tissues around a joint, fibrosis in or around a joint, or bony fixation (ankylosis). Ligamentous laxity of the ACL in knee trauma

Muscle atrophy or weakness in rheumatoid arthritis

Palpable bogginess or doughiness of the synovial membrane indicates synovitis, which is often accompanied by effusion. Palpable joint fluid in effusion, tenderness over the tendon sheaths in tendinitis

Arthritis, tendinitis, bursitis, osteomyelitis

Tenderness and warmth over a thickened synovium may suggest arthritis or infection.

Redness over a tender joint suggests septic or gouty arthritis, or possibly rheumatoid arthritis.

Be especially alert to signs of inflammation and arthritis.

Swelling. Palpable swelling may involve: (1) the synovial membrane, which can feel boggy or doughy; (2) effusion from excess synovial fluid within the joint space; or (3) soft-tissue structures such as bursae, tendons, and tendon sheaths.

Warmth. Use the backs of your fingers to compare the involved joint with its unaffected contralateral joint, or with nearby tissues if both joints are involved.

Tenderness. Try to identify the specific anatomic structure that is tender. Trauma may also cause tenderness.

Redness. Redness of the overlying skin is the least common sign of inflammation near the joints.

If the person has painful joints, move the person gently. Patients may move more comfortably by themselves. Let them show you how they manage. If joint trauma is present, consider an x-ray before attempting movement.

The detail needed for examining the musculoskeletal system may vary widely. This section presents examination techniques for both comprehensive and targeted assessment of joint function. Patients with extensive or severe musculoskeletal problems will require more time. A briefer survey for those without musculoskeletal symptoms is outlined in Chapter 3 (see p. 69).

The Temporomandibular Joint (TMJ)

**INSPECTION AND PALPATION**

Inspect the joint for swelling or redness. Swelling may appear as a rounded bulge about 1 inch anterior to the external auditory meatus.
TECHNIQUES OF EXAMINATION

To locate and palpate the joint, place the tips of your index fingers just in front of the tragus of each ear and ask the patient to open his or her mouth. The fingertips should drop into the joint spaces as the mouth opens. Check for smooth range of motion; note any swelling or tenderness. Snapping or clicking may be felt or heard in normal people.

RANGE OF MOTION AND MANEUVERS

The temporomandibular joint has glide and hinge motions in its upper and lower portions, respectively. Grinding or chewing consists primarily of gliding movements in the upper compartments.

Range of motion is three-fold: ask the patient to demonstrate opening and closing, protrusion and retraction (by jutting the jaw forward), and lateral, or side-to-side, motion. Normally as the mouth is opened wide, three fingers can be inserted between incisors. During normal protrusion of the jaw, the bottom teeth can be placed in front of the upper teeth.

The Shoulder

INSPECTION

Observe the shoulder and shoulder girdle anteriorly, and inspect the scapulae and related muscles posteriorly. Note any swelling, deformity, or muscle atrophy or fasciculations (fine tremors of the muscles).

Look for swelling of the joint capsule anteriorly or a bulge in the subacromial bursa under the deltoid muscle. Survey the entire upper extremity for color change, skin alteration, or abnormal positioning.

EXAMPLES OF ABNORMALITIES

- Dislocation of the TMJ may be seen in trauma.
- Swelling, tenderness, and decreased range of motion suggest arthritis.
- Palpable crepitus or clicking may occur in poor occlusion, meniscus injury, or synovial swelling from trauma.
- Muscle atrophy points to lesions in the cervical nerves.
- Scoliosis may cause elevation of one shoulder. With anterior dislocation of the shoulder, the rounded lateral aspect of the shoulder appears flattened.
- With posterior dislocation of the shoulder (relatively rare), the anterior aspect of the shoulder is flattened and the humeral head appears more prominent.
- A significant amount of synovial fluid is needed before the joint capsule appears distended.
TECHNIQUES OF EXAMINATION

EXAMPLES OF ABNORMALITIES

See Table 15-4, Painful Shoulders (pp. 526–527).

PALSATION

If there is a history of shoulder pain, ask the patient to point to the painful area. The location of the pain may provide clues as to its origin:

- Top of the shoulder, radiating toward the neck—acromioclavicular joint
- Lateral aspect of the shoulder, radiating toward the deltoid insertion—rotator cuff
- Anterior shoulder—bicipital tendon

Now identify the bony landmarks of the shoulder and then palpate the area of pain. Locate the acromion process and press medially to locate the distal tip of the clavicle at the acromioclavicular joint. Palpate laterally and down a short step to the greater tubercle of the humerus, and then press medially to locate the coracoid process of the scapula. Next palpate the painful area and identify the structures involved.

RANGE OF MOTION AND MANEUVERS

The six motions of the shoulder girdle are flexion, extension, abduction, adduction, and internal and external rotation.

Watch for smooth, fluid movement as you stand in front of the patient and ask the patient to (1) raise (abduct) the arms to shoulder level (90°) with palms facing down (tests pure glenohumeral motion); (2) raise the arms to a vertical position above the head with the palms facing each other (tests scapulothoracic motion for 60°, and combined glenohumeral and scapulothoracic motion during adduction for the final 30°); (3) place both hands behind the neck, with elbows out to the side (tests external rotation and abduction); and (4) place both hands behind the small of the back (tests internal rotation and adduction). (Placing your hand on the shoulder during these movements allows you to detect any crepitus.)

Inability to perform these movements may reflect weakness or soft-tissue changes from bursitis, capsulitis, rotator cuff tears or sprains, or tendinitis.
The examination of the shoulder often requires selective evaluation of the acromioclavicular joint, the subacromial and subdeltoid bursae, the rotator cuff, the bicipital groove and tendon, and the articular capsule and synovial membrane of the glenohumeral joint. Techniques for examining these structures are described on following pages.

### Localized Tenderness or Pain with Adduction
Localized tenderness or pain with adduction suggests inflammation or arthritis of the acromioclavicular joint. See Table 15-4, Painful Shoulders (pp. 526–527).

### Localized Tenderness arises from Subacromial or Subdeltoid Bursitis, Degenerative Changes or Calcific Deposits in the Rotator Cuff
Swelling suggests a bursal tear with communication into the articular cavity.

### Tenderness over the “SITS” Muscle Insertions and Inability to Lift the Arm above Shoulder Level are seen in Sprains, Tears, and Tendon Rupture of the Rotator Cuff
Most commonly the supraspinatus. See Table 15-4, Painful Shoulders (pp. 526–527).

### Techniques of Examination

<table>
<thead>
<tr>
<th>Structure</th>
<th>Techniques for Examining the Shoulder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acromioclavicular Joint</td>
<td>Palpate and compare both joints for swelling or tenderness. Adduct the patient’s arm across the chest, sometimes called the “crossover test.”</td>
</tr>
<tr>
<td>Subacromial and Subdeltoid Bursae</td>
<td>Passively extend the shoulder by lifting the elbow posteriorly. This exposes the bursae anterior to the acromion. Palpate carefully over the sub-acromial and subdeltoid bursae.</td>
</tr>
</tbody>
</table>
| Rotator Cuff               | With the patient’s arm hanging at the side, palpate the three “SITS” muscles that insert on the greater tuberosity of the humerus. (The fourth muscle, the subscapularis, inserts anteriorly and is not palpable.)
  - Supraspinatus—directly under the acromion
  - Infraspinatus—posterior to supraspinatus
  - Teres minor—posterior and inferior to the supraspinatus
| Subacromial bursa          | Passively extend the shoulder by lifting the elbow posteriorly. This maneuver also moves the rotator cuff out from under the acromion. Palpate the rounded SITS muscle insertions near the greater tuberosity of the humerus. |

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**EXAMPLES OF ABNORMALITIES**

Tenderness over the “SITS” muscle insertions and inability to lift the arm above shoulder level are seen in sprains, tears, and tendon rupture of the rotator cuff, most commonly the supraspinatus. See Table 15-4, Painful Shoulders (pp. 526–527).
If the patient is unable to hold the arm fully abducted at shoulder level, the “drop arm” test is positive, indicating a tear in the rotator cuff.

See also Bicipital Tendinitis in Table 15-4 Painful Shoulders (pp. 526–527).

Tenderness or pain against resistance occurs with tenosynovitis of the bicipital tendon sheath, tendinitis, or biceps tendon rupture.

Tenderness and effusion suggest synovitis of the glenohumeral joint. If the margins of the capsule and synovial membrane are palpable, a moderate to large effusion is present. Minimal degrees of synovitis at the glenohumeral joint cannot be detected on palpation.

The following maneuvers test individual muscles of the shoulder girdle and help localize pain. Note that medial rotation against resistance also tests the pectoralis major, teres major, and latissimus dorsi. Additional evaluation of muscle strength, sensation over the neck, shoulder, and arm, and upper extremity reflexes is often warranted to complete your assessment (see pp. 573–575).
The Elbow

**INSPECTION AND PALPATION**

Support the patient’s forearm with your opposite hand so the elbow is flexed to about 70°. Identify the medial and lateral epicondyles and the olecranon process of the ulna. Inspect the contours of the elbow, including the extensor surface of the ulna and the olecranon process. Note any nodules or swelling.

Palpate the olecranon process and press on the epicondyles for tenderness. Note any displacement of the olecranon.

Palpate the grooves between the epicondyles and the olecranon, noting any tenderness, swelling, or thickening. The synovium is most accessible to examination between the olecranon and the epicondyles. (Normally neither synovium nor bursa is palpable.) The sensitive ulnar nerve can be felt posteriorly between the olecranon process and the medial epicondyle.

**RANGE OF MOTION AND MANEUVERS**

Range of motion includes flexion and extension at the elbow and pronation and supination of the forearm. To test flexion and extension, ask the patient to bend and straighten the elbow.
TECHNIQUES OF EXAMINATION

With the patient’s arms at the sides and elbows flexed to minimize shoulder movement, ask the patient supinate, or turn up the palms, and to pronate, or turn down the palms.

The Wrist and Hand

INSPECTION

Observe the position of the hands in motion to see if movements are smooth and natural. At rest the fingers should be slightly flexed and aligned almost in parallel.

Inspect the palmar and dorsal surfaces of the wrist and hand carefully for swelling over the joints.

Note any deformities of the wrist, hand, or finger bones, as well as any angulation from radial or ulnar deviation.

Observe the contours of the palm, namely the thenar and hypothenar eminences.

Note any thickening of the flexor tendons or flexion contractures in the fingers.

PALPATION

At the wrist, palpate the distal radius and ulna on the lateral and medial surfaces. Palpate the groove of each wrist joint with your thumbs on the dorsum of the wrist, your fingers beneath it. Note any swelling, bogginess, or tenderness.
Palpate the anatomic snuffbox, a hollowed depression just distal to the radial styloid process formed by the abductor and extensor muscles of the thumb. The “snuffbox” becomes more visible with lateral extension of the thumb away from the hand.

Palpate the eight carpal bones lying distal to the wrist joint, and then each of the five metacarpals and the proximal, middle, and distal phalanges.

Palpate any other area where you suspect an abnormality.

Compress the MCP joints by squeezing the hand from each side between the thumb and fingers. Alternatively, use your thumb to palpate each MCP joint just distal to and on each side of the knuckle as your index finger feels the head of the metacarpal in the palm. Note any swelling, bogginess, or tenderness.

Now examine the fingers. Palpate the medial and lateral aspects of each PIP joint between your thumb and index finger, again checking for swelling, bogginess, bony enlargement, or tenderness.

Using the same techniques, examine the DIP joints.

EXAMPLES OF ABNORMALITIES

Gonococcal infection may involve the wrist joint (arthritis) or the tendon sheaths at the wrist (gonococcal tenosynovitis).

Tenderness over the “snuffbox” suggests a scaphoid fracture.

Synovitis in the MCPs is painful with this pressure—a point to remember when shaking hands.

The MCPs are often boggy or tender in rheumatoid arthritis (but rarely involved in osteoarthritis).

PIP changes seen in rheumatoid arthritis; Bouchard’s nodes in osteoarthritis

Hard dorsolateral nodules on the DIP joints, or Heberden’s nodes, common in osteoarthritis
TECHNIQUES OF EXAMINATION

In any area of swelling or inflammation, palpate along the tendons inserting on the thumb and fingers.

RANGE OF MOTION AND MANEUVERS

Now assess range of motion for the wrists, fingers, and thumbs. At the wrist, test flexion, extension, and ulnar and radial deviation.

- **Flexion.** With the patient’s forearm stabilized, place the wrist in extension and place your fingertips in the patient’s palm. Ask the patient to flex the wrist against gravity, then against graded resistance.

- **Extension.** With the patient’s forearm stabilized, place the wrist in flexion and put your hand on the patient’s dorsal metacarpals. Ask the patient to extend the wrist against gravity, then against graded resistance.

- **Ulnar and radial deviation.** With palms down, ask the patient to move the wrists laterally and medially.

Test flexion, extension, abduction, and adduction of the fingers:

- **Flexion and extension.** Ask the patient to make a tight fist with each hand, thumb across the knuckles, and then extend and spread the fingers. The fingers should close and open smoothly and easily. At the MCPs, the

EXAMPLES OF ABNORMALITIES

Tenderness and swelling in tenosynovitis, or inflammation of the tendon sheaths. De Quervain’s tenosynovitis over the extensor and abductor tendons of the thumb as they cross the radial styloid

Conditions that impair range of motion include arthritis, tenosynovitis, Dupuytren’s contracture. See Table 15-6, Swelling and Deformities of the Hands (pp. 529–531).
fingers may extend beyond the neutral position. Also test flexion and
extension at the PIP and DIP joints.

- Abduction and adduction. Ask the patient to spread the fingers apart (ab-
duction) and back together (adduction). Check for smooth, coordinated
movement.

At the thumb, assess flexion, exten-
sion, abduction, adduction, and oppo-
sition. Ask the patient to move the
thumb across the palm and touch
the base of the 5th finger to test flex-
ion, and then to move the thumb
back across the palm and away from
the fingers to test extension.

Next, ask the patient to place the fin-
gers and thumb in the neutral posi-
tion with the palm up, then have the
patient move the thumb anteriorly
away from the palm to assess abduc-
tion and back down for adduction.
To test opposition, or movements of
the thumb across the palm, ask the
patient to touch the thumb to each
of the other fingertips.

Test sensation in the fingers only along the lateral and medial surfaces to iso-
late any alterations in the digital nerves. Test median, ulnar, and radial nerve
function by checking sensation as follows:
The Spine

INSPECTION

Begin by observing the patient’s posture, including the position of both neck and trunk, when entering the room.

Assess the patient for erect position of the head, smooth, coordinated neck movement, and ease of gait.

Drape or gown the patient to expose the entire back for complete inspection. If possible, the patient should be upright in the patient’s natural standing position—with feet together and arms hanging at the sides. The head should be midline in the same plane as the sacrum, and the shoulders and pelvis should be level.

Inspect the patient from the side. Evaluate the spinal curvatures.

Neck stiffness signals arthritis, muscle strain, or other underlying pathology that should be pursued.

Lateral deviation and rotation of the head suggests torticollis, from contraction of the sternocleidomastoid muscle.
Increased thoracic kyphosis occurs with aging. In children a correctable structural deformity should be pursued.

In scoliosis, there is lateral and rotatory curvature of the spine to bring the head back to midline. Scoliosis often becomes evident during adolescence, before symptoms appear.

Unequal shoulder heights seen in Sprengel’s deformity of the scapula (from the attachment of an extra bone or band between the upper scapula and C7); in “wining” of the scapula (from loss of innervation of the serratus anterior muscle by the long thoracic nerve), and in contralateral weakness of the trapezius.

Unequal heights of the iliac crests, or pelvic tilt, suggest unequal lengths of the legs and disappear when a block is placed under the short leg and foot. Scoliosis and hip abduction or adduction may also cause a pelvic tilt. “Listing” of the trunk to one side is seen with a herniated lumbar disc.

Birthmarks, port-wine stains, hairy patches, and lipomas often overlie bony defects such as spina bifida.

Café-au-lait spots (discolored patches of skin), skin tags, and fibrous tumors in neurofibromatosis.
PALPATION

From a sitting or standing position, palpate the spinous processes of each vertebra with your thumb.

In the neck, also palpate the facet joints that lie between the cervical vertebrae about 1 inch lateral to the spinous processes of C2–C7. These joints lie deep to the trapezius muscle and may not be palpable unless the neck muscles are relaxed.

In the lower lumbar area, check carefully for any vertebral “step-offs” to determine if one spinous process seems unusually prominent (or recessed) in relation to the one above it. Identify any tenderness.

Palpate over the sacroiliac joint, often identified by the dimple overlying the posterior superior iliac spine.

You may wish to percuss the spine for tenderness by thumping, but not too roughly, with the ulnar surface of your fist.

Inspect and palpate the paravertebral muscles for tenderness and spasm. Muscles in spasm feel firm and knotted and may be visible.

With the hip flexed and the patient lying on the opposite side, palpate the sciatic nerve, the largest nerve in the body, consisting of nerve roots from L4, L5, S1, S2, and S3. The nerve lies midway between the greater trochanter and the ischial tuberosity as it leaves the pelvis through the sciatic notch.

EXAMPLES OF ABNORMALITIES

Tenderness suggests fracture or dislocation if preceded by trauma, underlying infection, or arthritis.

Tenderness occurs with arthritis, especially at the facet joints between C5 and C6.

Step-offs in spondylolisthesis, or forward slippage of one vertebra, which may compress the spinal cord. Vertebral tenderness is suspicious for fracture or infection.

Tenderness over the sacroiliac joint pinpoints a common cause of low back pain. Ankylosing spondylitis may produce sacroiliac tenderness.

Pain on percussion may arise from osteoporosis, infection, or malignancy.

Spasm occurs in degenerative and inflammatory processes of muscles, prolonged contraction from abnormal posture, or anxiety.

Sciatic nerve tenderness suggests a herniated disc or mass lesion impinging on the contributing roots.
Palpate for tenderness in any other areas that are suggested by the patient’s symptoms. Recall that low back pain warrants careful assessment for cord compression, the most serious cause of pain due to risk of paralysis of the affected limb.

**RANGE OF MOTION AND MANEUVERS**

The neck is the most mobile portion of the spine, remarkable for its seven fragile vertebrae supporting the 10- to 15-pound ball of the head. Flexion and extension occur primarily between the skull and C1 (the atlas), rotation at C1–C2 (the axis), and lateral bending at C2–C7.

Ask the patient to perform the following maneuvers, and check for smooth, coordinated motion:

- **Flexion.** Touch the chin to the chest.
- **Extension.** Look up at the ceiling.
- **Rotation.** Turn the head to each side, looking directly over the shoulder.
- **Lateral bending.** Tilt the head, touching each ear to the corresponding shoulder.

Tenderness, loss of sensation, or impaired movement warrants careful neurologic testing of the neck and upper extremities.

Now assess range of motion in the spinal column.

**EXAMPLES OF ABNORMALITIES**

Herniated intervertebral discs, most common between L5 and S1 or between L4 and L5, may produce tenderness of the spinous processes, the intervertebral joints, the paravertebral muscles, the sacrosciatic notch, and the sciatic nerve.

Rheumatoid arthritis may also cause tenderness of the intervertebral joints.

Remember that tenderness in the costovertebral angles may signify kidney infection rather than a musculoskeletal problem.

See Table 15-1, Low Back Pain (p. 522).

Limitations in range of motion may reflect stiffness from arthritis, pain from trauma, or muscle spasm such as torticollis.

It is important to assess any complaints or findings of neck, shoulder, or arm pain or numbness for possible cervical cord or nerve root compression. See Table 15-2, Pains in the Neck (p. 523).

Tenderness at C1–C2 in rheumatoid arthritis suggests possible risk of subluxation and high cervical cord compression.
**Flexion.** Ask the patient to bend forward to touch the toes (flexion). Note the smoothness and symmetry of movement, the range of motion, and the curve in the lumbar area. As flexion proceeds, the lumbar concavity should flatten out.

You may wish to measure the degree of flexion of the spine with the patient standing and bending forward. Mark the spine at the lumbosacral junction, then 10 cm above and 5 cm below this point. A 4-cm increase between the two upper marks is normally seen. The distance between the lower two marks should be unchanged.

**Extension.** Place your hand on the posterior superior iliac spine, with your fingers pointing toward the midline, and ask the patient to bend backward as far as possible.

**Rotation.** Stabilize the pelvis by placing one hand on the patient’s hip and the other on the opposite shoulder. Then rotate the trunk by pulling the shoulder and then the hip posteriorly. Repeat these maneuvers for the opposite side.

**EXAMPLES OF ABNORMALITIES**

- Deformity of the thorax on forward bending in scoliosis.
- Persistence of lumbar lordosis suggests muscle spasm or ankylosing spondylitis.
- Decreased spinal mobility in osteoarthritis and ankylosing spondylitis, among other conditions.
**Lateral bending.** Again stabilize the pelvis by placing your hand on the patient’s hip. Ask the patient to lean to both sides as far as possible.

As with the neck, pain or tenderness with these maneuvers, particularly with radiation into the leg, warrants careful neurologic testing of the lower extremities.

**Underlying cord or nerve root compression should be considered. Note that arthritis or infection in the hip, rectum, or pelvis may cause symptoms in the lumbar spine. See Table 15-1, Low Back Pain (p. 522).**

**The Hip**

**INSPECTION**

Inspection of the hip begins with careful observation of the patient’s gait on entering the room. Observe the two phases of gait:
Most problems appear during the weight-bearing stance phase.

A wide base suggests cerebellar disease or foot problems.

Hip dislocation, arthritis, or abductor weakness can cause the pelvis to drop on the opposite side, producing a waddling gait.

Lack of knee flexion interrupts the smooth pattern of gait.

Loss of lordosis may reflect paravertebral spasm; excess lordosis suggests a flexion deformity of the hip.

Changes in leg length are seen in abduction or adduction deformities and scoliosis. Leg shortening and external rotation suggest hip fracture.

Observe the lumbar portion of the spine for slight lordosis and, with the patient supine, assess the length of the legs for symmetry. (To measure leg length, see Special Techniques, pp. 520–521).

Inspect the anterior and posterior surfaces of the hip for any areas of muscle atrophy or bruising.
PALPATION

Review the surface landmarks of the hip. On the anterior surface locate the iliac crest, the iliac tubercle, and the anterior superior iliac spine. On the posterior surface identify the posterior superior iliac spine, the greater trochanter, the ischial tuberosity, and the sciatic nerve.

With the patient supine, ask the patient to place the heel of the leg being examined on the opposite knee. Then palpate along the inguinal ligament, which extends from the anterior superior iliac spine to the pubic tubercle. The femoral nerve, artery, and vein bisect the overlying inguinal ligament; lymph nodes lie medially. The mnemonic N A V E L may help you remember the lateral-to-medial sequence of Nerve—Artery—Vein—Empty space—Lymph node.

If the hip is painful, palpate the iliopsoas (ilipectineal) bursa, below the inguinal ligament but on a deeper plane.

With the patient resting on one side and the hip flexed and internally rotated, palpate the trochanteric bursa lying over the greater trochanter. Normally, the ischiogluteal bursa, over the ischial tuberosity, is not palpable unless inflamed.

Bulges along the ligament may suggest an inguinal hernia or, on occasion, an aneurysm.

Enlarged lymph nodes suggest infection in the lower extremity or pelvis.

Tenderness may be due to synovitis of the hip joint, bursitis, or possibly psoas abscess.

Swelling with tenderness suggests trochanteric bursitis. Tenderness without swelling on the posterolateral surface of the greater trochanter suggests localized tendinitis or muscle spasm from referred hip pain.

Tenderness and swelling in ischiogluteal bursitis or “weaver’s bottom”—because of the adjacent sciatic nerve, this may mimic sciatica.
Examples of Abnormalities

Range of Motion and Maneuvers

Motions at the hip include flexion, extension, abduction, adduction, and rotation. Note that the hip can flex farther when the knee is also flexed. Rotation at the hip while the knee is flexed may be confusing at first: when the lower leg swings laterally, the femur rotates internally. It is the motion of the femur at the hip joint that identifies these movements.

- **Flexion.** With the patient supine, place your hand under the patient’s lumbar spine. Ask the patient to bend each knee in turn up to the chest and pull it firmly against the abdomen. Note when the back touches your hand, indicating normal flattening of the lumbar lordosis—further flexion must arise from the hip joint itself.

As the thigh is held against the abdomen, observe the degree of flexion at the hip and knee. Normally the anterior portion of the thigh can almost touch the chest wall. Note whether the opposite thigh remains fully extended, resting on the table.

- **Extension.** With the patient lying face down, extend the thigh toward you in a posterior direction.

- **Abduction.** Stabilize the pelvis by pressing down on the opposite anterior superior iliac spine with one hand. With the other hand, grasp the ankle and abduct the extended leg until you feel the iliac spine move. This movement marks the limit of hip abduction.

Alternatively, stand at the foot of the table, grasp both ankles, and spread them maximally, abducting both extended legs at the hips. This method

In flexion deformity of the hip, as the opposite hip is flexed (with the thigh against the chest), the affected hip does not allow full leg extension and the affected thigh appears flexed.

Flexion deformity may be masked by an increase, rather than flattening, in lumbar lordosis and an anterior pelvic tilt.

Restricted abduction is common in hip disease from osteoarthritis.

**HIP FLEXION AND FLATTENING OF LUMBAR LORDOSIS**

**CHAPTER 15  THE MUSCULOSKELETAL SYSTEM**
provides easy comparison of two sides when movements are restricted, but it is impractical when range of motion is full.

- **Adduction.** With the patient supine, stabilize the pelvis, hold one ankle, and move the leg medially across the body and over the opposite extremity.

- **Rotation.** Flex the leg to $90^\circ$ at hip and knee, stabilize the thigh with one hand, grasp the ankle with the other, and swing the lower leg—medially for external rotation at the hip and laterally for internal rotation.

  Restriction of internal rotation is an especially sensitive indicator of hip disease such as arthritis. External rotation is also often restricted.
The Knee and Lower Leg

INSPECTION

Observe the gait for a smooth, rhythmic flow as the patient enters the room. The knee should be extended at heel strike and flexed at all other phases of swing and stance.

Check the alignment and contours of the knees. Observe any atrophy of the quadriceps muscles.

Look for loss of the normal hollows around the patella, a sign of swelling in the knee joint and suprapatellar pouch; note any other swelling in or around the knee.

PALPATION

Ask the patient to sit on the edge of the examining table with the knees in flexion. In this position, bony landmarks are more visible and the muscles, tendons, and ligaments are more relaxed, making them easier to palpate.

First review the important bony landmarks of the knee. Facing the knee, place your thumbs in the soft-tissue depressions on either side of the patellar tendon. On the medial aspect, move your thumb upward and then downward and identify the medial femoral condyle and the upper margin of the medial tibial plateau. Trace the patellar tendon distally to the tibial tubercle. The adductor tubercle is posterior to the medial femoral condyle.
Lateral to the patellar tendon, identify the lateral femoral condyle and the lateral tibial plateau. The medial and lateral femoral epicondyles are lateral to the condyles with the knee in flexion. Locate the patella.

Palpate the ligaments, the borders of the menisci, and the bursae of the knee, paying special attention to any areas of tenderness. Pain is a common complaint in knee problems, and localizing the structure causing pain is important for accurate evaluation.

In the patellofemoral compartment, palpate the patellar tendon and ask the patient to extend the leg to make sure the tendon is intact.

With the patient supine and the knee extended, push the patella against the underlying femur. Ask the patient to tighten the quadriceps as the patella moves distally in the trochlear groove. Check for a smooth sliding motion (the patellofemoral grinding test).

Now assess the medial and lateral compartments of the tibiofemoral joint. Flex the patient’s knee to about 90°. The patient’s foot should rest on the examining table. Palpate the medial collateral ligament (MCL) between the medial femoral epicondyle and the femur; then palpate the cordlike lateral

Tenderness over the tendon or inability to extend the leg suggests a partial or complete tear of the patellar tendon.

Pain and crepitus suggest roughening of the patellar undersurface that articulates with the femur. Similar pain may occur with climbing stairs or getting up from a chair.

Pain with patellar movement during quadriceps contraction suggests chondromalacia, or degenerative patella.

MCL tenderness after injury is suspicious for an MCL tear. (The LCL is less subject to injury.)
collateral ligament (LCL) between the lateral femoral epicondyle and the fibular head.

Palpate the medial and lateral menisci along the medial and lateral joint lines. It is easier to palpate the medial meniscus if the tibia is internally rotated. Note any swelling or tenderness.

Note any irregular bony ridges along the joint margins.

Try to feel any thickening or swelling in the suprapatellar pouch and along the sides of the patella. Start 10 centimeters above the superior border of the patella (well above the pouch) and feel the soft tissues between your thumb and fingers. Move your hand distally in progressive steps, trying to identify the pouch. Continue your palpation along the sides of the patella. Note any tenderness or warmth greater than in the surrounding tissues.

Check three other bursae for bogginess or swelling. Palpate the prepatellar bursa, and over the anserine bursa on the posteromedial side of the knee between the medial collateral ligament and the tendons inserting on the medial tibial and plateau. On the posterior surface, with the leg extended, check the medial aspect of the popliteal fossa.

Three further tests will help you detect fluid in the knee joint.

The Bulge Sign (for minor effusions). With the knee extended, place the left hand above the knee and apply pressure on the suprapatellar pouch, displacing or “milking” fluid downward. Stroke downward on the medial aspect of the knee and apply pressure to force fluid into the lateral area. Tap the knee just behind the lateral margin of the patella with the right hand.

TECHNIQUES OF EXAMINATION

EXAMPLES OF ABNORMALITIES

Tenderness from tears following injury are more common in the medial than in the lateral meniscus.

Bony ridges along the joint margins may be felt in osteoarthritis.

Swelling above and adjacent to the patella suggests synovial thickening or effusion in the knee joint.

Thickening, bogginess, or warmth in these areas indicates synovitis or nontender effusions from osteoarthritis.

Prepatellar bursitis (“housemaid’s knee”) from excessive kneeling. Anserine bursitis from running, valgus knee deformity, fibromyalgias, osteoarthritis. A popliteal or “baker’s” cyst from distention of the gastrocnemius semimembranosus bursa.

A fluid wave or bulge on the medial side between the patella and the femur is considered a positive bulge sign consistent with an effusion.
The Balloon Sign (for major effusions). Place the thumb and index finger of your right hand on each side of the patella; with the left hand, compress the suprapatellar pouch against the femur. Feel for fluid entering (or ballooning into) the spaces next to the patella under your right thumb and index finger.

Palpable fluid returning into the pouch further confirms the presence of a large effusion.

Ballotting the patella. To assess large effusions, you can also compress the suprapatellar pouch and “ballotte” or push the patella sharply against the femur. Watch for fluid returning to the suprapatellar pouch.

A palpable patellar click with compression may also occur, but yields more false positives.

When the knee joint contains a large effusion, suprapatellar compression ejects fluid into the spaces adjacent to the patella. A palpable fluid wave signifies a positive “balloon sign.” A returning fluid wave into the suprapatellar pouch confirms an effusion.
RANGE OF MOTION AND MANEUVERS

The principal movements of the knee are flexion, extension, and internal and external rotation. Ask the patient to flex and extend the knee while sitting. To check internal and external rotation, instruct the patient to rotate the foot medially and laterally. Knee flexion and extension can also be assessed by asking the patient to squat and stand up—provide support if needed to maintain balance.

You will often need to test ligamentous stability and integrity of the menisci, particularly when there is a history of trauma or palpable tenderness. Always examine both knees and compare findings.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Maneuver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medial collateral ligament (MCL)</td>
<td>Abduction Stress Test. With the patient supine and the knee slightly flexed, move the thigh about 30° laterally to the side of the table. Place one hand against the lateral knee to stabilize the femur and the other hand around the medial ankle. Push medially against the knee and pull laterally at the ankle to open the knee joint on the medial side (valgus stress).</td>
</tr>
<tr>
<td>Lateral collateral ligament (LCL)</td>
<td>Adduction Stress Test. Now, with the thigh and knee in the same position, change your position so you can place one hand against the medial surface of the knee and the other around the lateral ankle. Push medially against the knee and pull laterally at the ankle to open the knee joint on the lateral side (varus stress).</td>
</tr>
<tr>
<td>Anterior cruciate ligament (ACL)</td>
<td>Anterior Drawer Sign. With the patient supine, hips flexed and knees flexed to 90° and feet flat on the table, cup your hands around the knee with the thumbs on the medial and lateral joint line and the fingers on the medial and lateral insertions of the hamstrings. Draw the tibia forward and observe if it slides forward (like a drawer) from under the femur. Compare the degree of forward movement with that of the opposite knee.</td>
</tr>
</tbody>
</table>

Pain or a gap in the medial joint line points to ligamentous laxity and a partial tear of the medial collateral ligament. Most injuries are on the medial side.

Pain or a gap in the lateral joint line points to ligamentous laxity and a partial tear of the lateral collateral ligament.

A few degrees of forward movement are normal if equally present on the opposite side.

A forward jerk showing the contours of the upper tibia is a positive anterior drawer sign and suggests a tear of the ACL.
Palpate the *gastrocnemius* and *soleus muscles* on the posterior surface of the lower leg. Their common tendon, the *Achilles*, is palpable from about the lower third of the calf to its insertion on the calcaneus.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Maneuver</th>
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<tbody>
<tr>
<td>Posterior cruciate ligament (PCL)</td>
<td>Lachman Test. Place the knee in 15° of flexion and external rotation. Grasp the distal femur with one hand and the upper tibia with the other. With the thumb of the tibial hand on the joint line, simultaneously move the tibia forward and the femur back. Estimate the degree of forward excursion.</td>
</tr>
<tr>
<td>Medial meniscus and lateral meniscus</td>
<td>Posterior Drawer Sign. Position the patient and place your hands in the positions described for the anterior drawer test. Push the tibia posteriorly and observe the degree of backward movement in the femur. McMurray Test. If a click is felt or heard at the joint line during flexion and extension of the knee, or if tenderness is noted along the joint line, further assess the meniscus for a posterior tear. With the patient supine, grasp the heel and flex the knee. Cup your other hand over the knee joint with fingers and thumb along the medial and lateral joint line. From the heel, rotate the lower leg internally and externally. Then push on the lateral side to apply a valgus stress on the medial side of the joint. At the same time, rotate the leg externally and slowly extend it.</td>
</tr>
</tbody>
</table>

Significant forward excursion indicates an ACL tear.

Isolated PCL tears are rare.

A click or pop along the medial joint with valgus stress, external rotation, and leg extension suggests a probable tear of the posterior portion of the medial meniscus.

A defect in the muscles with tenderness and swelling in a *ruptured Achilles tendon*; tenderness and thickening of the tendon above the calcaneus, sometimes with a protuberant posterolateral bony process of the calcaneus in *Achilles tendinitis*. 
TECHNIQUES OF EXAMINATION

To test the integrity of the *Achilles tendon*, place the patient prone with the knee and ankle flexed at 90°, or alternatively, ask the patient to kneel on a chair. Squeeze the calf and watch for plantar flexion at the ankle.

EXAMPLES OF ABNORMALITIES

Absence of plantar flexion is a positive test indicating rupture of the *Achilles tendon*. Sudden severe pain “like a gunshot wound,” an ecchymosis from the calf into the heel, and a flat-footed gait with absence of “toe-off” may also be present.

The Ankle and Foot

INSPECTION

Observe all surfaces of the ankles and feet, noting any deformities, nodules, or swellings, and any calluses or corns.

See Table 15-7, Abnormalities of the Feet and Toes (pp. 532–533).

PALPATION

With your thumbs, palpate the anterior aspect of each *ankle joint*, noting any bogginess, swelling, or tenderness.

Localized tenderness in arthritis, ligamentous injury, or infection of the ankle

Feel along the *Achilles tendon* for nodules and tenderness.

Rheumatoid nodules; tenderness in Achilles tendinitis, bursitis, or partial tear from trauma

Palpate the heel, especially the posterior and inferior calcaneus, and the plantar fascia for tenderness.

Bone spurs may be present on the calcaneus; pain over the plantar fascia suggests *plantar fasciitis*.

Palpate the *metatarsophalangeal joints* for tenderness. Compress the forefoot between the thumb and fingers. Exert pressure just proximal to the heads of the 1st and 5th metatarsals.

Tenderness on compression is an early sign of rheumatoid arthritis. Acute inflammation of the first metatarsophalangeal joint is associated with gout.
TECHNIQUES OF EXAMINATION

Palpate the heads of the five metatarsals and the grooves between them with your thumb and index finger. Place your thumb on the dorsum of the foot and your index finger on the plantar surface.

RANGE OF MOTION AND MANEUVERS

Range of motion at the ankle includes flexion and extension at the ankle (tibiotalar) joint and, in the foot, inversion and eversion at the subtalar and transverse tarsal joints.

- **The Ankle (Tibiotalar) Joint.** Dorsiflex and plantar flex the foot at the ankle.

- **The Subtalar (Talocalcaneal) Joint.** Stabilize the ankle with one hand, grasp the heel with the other, and invert and evert the foot.

- **The Transverse Tarsal Joint.** Stabilize the heel and invert and evert the forefoot.

- **For the Metatarsophalangeal joints,** flex the toes in relation to the feet.

EXAMPLES OF ABNORMALITIES

- Pain and tenderness, called *metatarsalgia,* seen in trauma, arthritis, vascular compromise.

Pain during movements of the ankle and the foot helps to localize possible arthritis.

An arthritic joint is frequently painful when moved in any direction, while a ligamentous sprain produces maximal pain when the ligament is stretched. For example, in a common form of sprained ankle, inversion and plantar flexion of the foot cause pain, while eversion and plantar flexion are relatively pain free.
Special Techniques

For the Carpal Tunnel Syndrome.  Pain and numbness on the ventral surface of the first three digits of the hand (but not in the palm), especially at night, suggest median nerve compression in the carpal tunnel, which lies between the carpal bones dorsally and a ventral band of more superficial fascia, the *flexor retinaculum*.

Appropriate symptoms and objective loss of sensation on the ventral surface of the hand in the distribution of the median nerve (see p. 473 and p. 474), and *weak abduction of the thumb* on muscle strength testing are the most helpful for making the diagnosis. Two additional clinical tests are also used—when positive, Tinel’s test appears more likely to be confirmed by further diagnostic testing.

**Thumb Abduction.** Ask the patient to raise the thumb perpendicular to the palm as you apply downward pressure on the distal phalanx. (This maneuver reliably tests the strength of the abductor pollicis brevis, which is innervated only by the median nerve.)

**Tinel’s Sign.** With your finger, percuss lightly over the course of the median nerve in the carpal tunnel at the spot indicated by the arrow.
Phalen’s Test. Hold the patient’s wrists in acute flexion for 60 seconds. Alternatively, ask the patient to press the backs of both hands together to form right angles. These maneuvers compress the median nerve.

For Low Back Pain With Radiation Into the Leg. If the patient has noted low back pain that radiates down the leg, check straight leg raising on each side in turn. The patient should be lying supine. Raise the patient’s relaxed and straightened leg until pain occurs. Then dorsiflex the foot.

Record the degree of elevation at which pain occurs, the quality and distribution of the pain, and the effects of dorsiflexion. Tightness and mild discomfort in the hamstrings with these maneuvers are common and do not indicate radicular pain.

Examples of Abnormalities

If numbness and tingling develop over the distribution of the median nerve (e.g., the palmar surface of the thumb, and the index, middle, and part of the ring fingers), the sign is positive, suggesting carpal tunnel syndrome.

Sharp pain radiating from the back down the leg in an L5 or S1 distribution (radicular pain) suggests tension on or compression of the nerve root(s), often caused by a herniated lumbar disc. Dorsiflexion of the foot increases the pain. Increased pain in the affected leg when the opposite leg is raised strongly confirms radicular pain and constitutes a positive crossed straight leg-raising sign.

See Table 15-1 Low Back Pain (p. 522).

Unequal leg length may explain a scoliosis.

Examine the patient neurologically, focusing on the motor and sensory functions and the reflexes at the lumbosacral levels. These are outlined in the next chapter.

Measuring the Length of Legs. If you suspect that the patient’s legs are unequal in length, measure them. Get the patient relaxed in the supine
position and symmetrically aligned with legs extended. With a tape, measure the distance between the anterior superior iliac spine and the medial malleolus. The tape should cross the knee on its medial side.

**Describing Limited Motion of a Joint.** Although measurement of motion is seldom necessary, limitations can be described in degrees. Pocket goniometers are available for this purpose. In the two examples shown below, the red lines indicate the range of the patient’s movement and the black lines suggest the normal range.

A. The elbow flexes from 45° to 90° (45° → 90°),
   -or-
   The elbow has a flexion deformity of 45° and can be flexed farther to 90° (45° → 90°).

B. Supination at elbow = 30° (0° → 30°)
   Pronation at elbow = 45° (0° → 45°)

Observations may be described in several ways. The numbers in parentheses are suitably abbreviated recordings.
TABLE 15-1  ■ Low Back Pain

<table>
<thead>
<tr>
<th>Patterns</th>
<th>Possible Causes</th>
<th>Possible Physical Signs</th>
</tr>
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<tbody>
<tr>
<td>Mechanical Low Back Pain</td>
<td>Acute, often recurrent, or possibly chronic aching pain in the lumbosacral area, possibly radiating into the posterior thighs but not below the knees. The pain is often precipitated or aggravated by moving, lifting, or twisting motions and is relieved by rest. Spinal movements are typically limited by pain. This is the back pain common from the teenage years through the 40s.</td>
<td>The exact cause cannot usually be proven. Intervertebral disc disease is probably involved in many cases. Congenital disorders of the spine, such as spondylolisthesis, may be present in a small percentage. In older women or in persons on long-term corticosteroid therapy, consider osteoporosis complicated by a collapsed vertebra. Local tenderness, muscle spasm, pain on movement of the back, and loss of the normal lumbar lordosis, but no motor or sensory loss or reflex abnormalities. In osteoporosis there may be a thoracic kyphosis, percussion tenderness over a spinous process, or fractures elsewhere such as in the thoracic spine or in a hip.</td>
</tr>
<tr>
<td>Radicular Low Back Pain</td>
<td>A radicular (nerve root) pain, usually superimposed on low back pain. The sciatic pain is shooting and radiates down one or both legs, usually to below the knee(s) in a dermatomal distribution, often with associated numbness and tingling and possibly local weakness. The pain is usually worsened by spinal movement such as bending and by sneezing, coughing, or straining.</td>
<td>A herniated intervertebral disc with compression or traction of nerve root(s) is the most common cause in persons under age 50. The nerve roots of L5 or S1 are most often affected. Spinal cord tumors or abscesses are much less common causes. Compared to a disc, they tend to affect more nerve roots and to produce more neurologic deficits. Pain on straight leg raising (see pp. 520), tenderness of the sciatic nerve, loss of sensation in a dermatomal distribution, local muscular weakness and atrophy, and decreased to absent reflex(es), especially affecting the ankle jerks. Dermatomal signs and reflex changes may be absent when only a single root is affected.</td>
</tr>
<tr>
<td>Back and Leg Pain From Lumbar Stenosis</td>
<td>Pseudoclaudication is a pain in the back or legs that worsens with walking and improves with flexing of the spine, as by sitting or bending forward.</td>
<td>Lumbar stenosis, which is a combination of degenerative disc disease and osteoarthritis that narrows the spinal canal and impinges on the spinal nerves. It is a common cause of pain after age 60. The posture may become flexed forward. Motor weakness and hyporeflexia in the lower extremities may be present.</td>
</tr>
<tr>
<td>Chronic Persistent Low Back Stiffness</td>
<td>Ankylosing spondylitis, a chronic inflammatory polyarthritis, most common in young men</td>
<td>Local bone tenderness may be present.</td>
</tr>
<tr>
<td>Aching Nocturnal Back Pain, Unrelieved by Rest</td>
<td>Diffuse idiopathic skeletal hyperostosis (DISH), which affects middle-aged and older men</td>
<td>Loss of the normal lumbar lordosis, muscle spasm, and limitation of anterior and lateral flexion</td>
</tr>
<tr>
<td>Back Pain Referred From the Abdomen or Pelvis</td>
<td>Consider metastatic malignancy in the spine, as from cancer of the prostate, breast, lung, thyroid, and kidney, and multiple myeloma.</td>
<td>Flexion and immobility of the spine</td>
</tr>
<tr>
<td></td>
<td>Usually a deep, aching pain, the level of which varies with the source</td>
<td>Spinal movements are not painful and range of motion is not affected. Look for signs of the primary disorder.</td>
</tr>
<tr>
<td></td>
<td>Peptic ulcer, pancreatitis, pancreatic cancer, chronic prostatitis, endometriosis, dissecting aortic aneurysm, retroperitoneal tumor, and other causes</td>
<td></td>
</tr>
<tr>
<td>Patterns</td>
<td>Possible Causes</td>
<td>Possible Physical Signs</td>
</tr>
<tr>
<td>----------</td>
<td>----------------</td>
<td>------------------------</td>
</tr>
<tr>
<td><strong>“Simple Stiff Neck”</strong></td>
<td>Acute, episodic, localized pain in the neck, often appearing on awakening and lasting 1–4 days. No dermatomal radiation</td>
<td>The mechanisms are not understood.</td>
</tr>
<tr>
<td><strong>Aching Neck</strong></td>
<td>A persistent dull aching in the back of the neck, often spreading to the occiput. This is common with postural strain, as with prolonged typing or studying, and may also accompany tension and depression.</td>
<td>Poorly understood; may be related to sustained muscle contraction</td>
</tr>
<tr>
<td><strong>“Cervical Sprain”</strong></td>
<td>Acute and often recurrent neck pains that are often more severe and last longer than simple stiff neck. There may be a precipitating factor such as a whiplash injury, heavy lifting, or a sudden movement, but there is no dermatomal radiation.</td>
<td>Poorly understood</td>
</tr>
<tr>
<td><strong>Neck Pain With Dermatomal Radiation</strong></td>
<td>Neck pain as in cervical sprain, but with radiation of the pain to the shoulder, back, or arm in a dermatomal distribution. This radicular pain is typically sharp, burning, or tingling in quality.</td>
<td>Compression of one or more nerve roots caused by either a herniated cervical disc or degenerative disease of the intervertebral discs with bony spurring*</td>
</tr>
<tr>
<td><strong>Neck Pain From Possible Compression of the Cervical Spinal Cord</strong></td>
<td>Associated here is weakness or paralysis of the legs, often with a decrease in or loss of sensation. These symptoms may occur in addition to the radicular symptoms or by themselves. The neck pain may be mild or even absent.</td>
<td>Compression of the spinal cord in the neck caused by either a herniated cervical disc or degenerative disease of the intervertebral discs with bony spurring. Trauma may also be the cause.*</td>
</tr>
</tbody>
</table>

* Tumors or abscesses of the cervical spinal cord, though less common, should also be considered.
TABLE 15-3  ■ Patterns of Pain In and Around the Joints

<table>
<thead>
<tr>
<th>Problem</th>
<th>Process</th>
<th>Common Locations</th>
<th>Pattern of Spread</th>
<th>Onset</th>
<th>Progression and Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rheumatoid Arthritis</td>
<td>Chronic inflammation of synovial membranes with secondary erosion of adjacent cartilage and bone, and damage to ligaments and tendons</td>
<td>Hands (proximal interphalangeal and metacarpophalangeal joints), feet (metatarsophalangeal joints), wrists, knees, elbows, ankles</td>
<td>Symmetrically additive: progresses to other joints while persisting in the initial ones</td>
<td>Usually insidious</td>
<td>Often chronic, with remissions and exacerbations</td>
</tr>
<tr>
<td>Osteoarthritis (degenerative joint disease)</td>
<td>Degeneration and progressive loss of cartilage within the joints, damage to underlying bone, and formation of new bone at the margins of the cartilage</td>
<td>Knees, hips, hands (distal, sometimes proximal interphalangeal joints), cervical and lumbar spine, and wrists (first carpometacarpal joint); also joints previously injured or diseased</td>
<td>Additive; however, only one joint may be involved.</td>
<td>Usually insidious</td>
<td>Slowly progressive, with temporary exacerbations after periods of overuse</td>
</tr>
<tr>
<td>Gouty Arthritis</td>
<td>An inflammatory reaction to microcrystals of sodium urate</td>
<td>Base of the big toe (the first metatarsophalangeal joint), the instep or dorsum of feet, the ankles, knees, and elbows</td>
<td>Early attacks are usually confined to one joint.</td>
<td>Sudden, often at night, often after injury, surgery, fasting, or excessive food or alcohol intake</td>
<td>Occasional isolated attacks lasting days up to 2 weeks; they may get more frequent and severe, with persisting symptoms.</td>
</tr>
<tr>
<td>Acute Gout</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Chronic symptoms with acute exacerbations</td>
</tr>
<tr>
<td>Chronic Tophaceous Gout</td>
<td>Multiple local accumulations of sodium urate in the joints and other tissues (tophi), with or without inflammation</td>
<td>Feet, ankles, wrists, fingers, and elbows</td>
<td>Additive, not so symmetric as rheumatoid arthritis</td>
<td>Gradual development of chronicity with repeated attacks</td>
<td>Chronic symptoms with acute exacerbations</td>
</tr>
<tr>
<td>Polymyalgia Rheumatica</td>
<td>A disease of unclear nature seen in people over age 50, especially women; may be associated with giant cell arteritis</td>
<td>Muscles of the hip girdle and shoulder girdle; symmetric</td>
<td>Insidious or abrupt, even appearing overnight</td>
<td>Chronic but ultimately self-limiting</td>
<td></td>
</tr>
<tr>
<td>Fibromyalgia Syndrome</td>
<td>Widespread musculoskeletal pain and tender points. May accompany other diseases. Mechanisms unclear</td>
<td>“All over,” but especially in the neck, shoulders, hands, low back, and knees</td>
<td>Shifts unpredictably or worsens in response to immobility, excessive use, or chilling</td>
<td>Variable</td>
<td>Chronic, with “ups and downs”</td>
</tr>
</tbody>
</table>

The vagueness of these characteristics is in itself a clue to the fibromyalgia syndrome.
### TABLE 15-3 Patterns of Pain In and Around the Joints

<table>
<thead>
<tr>
<th>Swelling</th>
<th>Redness, Warmth, and Tenderness</th>
<th>Stiffness</th>
<th>Limitation of Motion</th>
<th>Generalized Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent swelling of synovial tissue in joints or tendon sheaths; also subcutaneous nodules</td>
<td>Tender, often warm, but seldom red</td>
<td>Prominent, often for an hour or more in the mornings, also after inactivity</td>
<td>Often develops</td>
<td>Weakness, fatigue, weight loss, and low fever are common.</td>
</tr>
<tr>
<td>Small effusions in the joints may be present, especially in the knees; also bony enlargement.</td>
<td>Possibly tender, seldom warm, and rarely red</td>
<td>Frequent but brief (usually 5–10 min), in the morning and after inactivity</td>
<td>Often develops</td>
<td>Usually absent</td>
</tr>
<tr>
<td>Present, within and around the involved joint</td>
<td>Exquisitely tender, hot, and red</td>
<td>Not evident</td>
<td>Motion is limited primarily by pain.</td>
<td>Fever may be present.</td>
</tr>
<tr>
<td>Present, as tophi, in joints, bursae, and subcutaneous tissues</td>
<td>Tenderness, warmth, and redness may be present during exacerbations.</td>
<td>Present</td>
<td>Present</td>
<td>Possibly fever; patient may also develop symptoms of renal failure and renal stones.</td>
</tr>
<tr>
<td>None</td>
<td>Muscles often tender, but not warm or red</td>
<td>Prominent, especially in the morning</td>
<td>Usually none</td>
<td>Malaise, a sense of depression, possibly anorexia, weight loss, and fever, but no true weakness</td>
</tr>
<tr>
<td>None</td>
<td>Multiple specific and symmetric tender “trigger points,” often not recognized until the examination</td>
<td>Present, especially in the morning</td>
<td>Absent, though stiffness is greater at the extremes of movement</td>
<td>A disturbance of sleep, usually associated with morning fatigue</td>
</tr>
<tr>
<td>TABLE 15-4</td>
<td>Painful Shoulders</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Rotator Cuff Tendinitis**
Repeated shoulder motion, as in throwing or swimming, can cause edema and hemorrhage followed by inflammation, most commonly involving the supraspinatus tendon. Acute, recurrent, or chronic pain may result, often aggravated by activity. Patients may report sharp catches of pain, grating, and weakness when lifting the arm overhead. When the supraspinatus tendon is involved, tenderness is maximal just below the tip of the acromion. Patients are typically athletically active.

**Rotator Cuff Tears**
When the arm is raised in forward flexion, the rotator cuff may impinge against the undersurface of the acromion and the coracoacromial ligament. Injury from a fall or repeated impingement may weaken the rotator cuff, causing a partial or complete tear, usually after age 40. Weakness, atrophy of the supraspinatus and infraspinatus muscles, pain, and tenderness may ensue. In a complete tear of the supraspinatus tendon (illustrated), active abduction and forward flexion at the glenohumeral joint is severely impaired, producing a characteristic shrugging of the shoulder.

**Calcific Tendinitis**
Calcific tendinitis refers to a degenerative process in the tendon that is associated with the deposition of calcium salts. Like rotator cuff tendinitis, it usually involves the supraspinatus tendon. Acute, disabling attacks of shoulder pain may occur, usually in patients over 30 years of age and more often in women. The arm is held close to the side, and all motions are severely limited by pain. Tenderness is maximal below the tip of the acromion. The subacromial bursa, which overlies the supraspinatus tendon, may become involved in the inflammation. Chronic, less severe pain may also occur.
Bicipital Tendinitis
Inflammation of the long head of the biceps tendon and its sheath causes anterior shoulder pain that may resemble rotator cuff tendinitis and may coexist with it. Often this is a sign of shoulder instability. This tendon, like the cuff, may suffer impingement injury. Tenderness is maximal in the bicipital groove. By externally rotating and abducting the arm, you can more easily separate this area from the subacromial tenderness of supraspinatus tendinitis. With the patient’s arm at the side, elbow flexed to 90°, ask the patient to supinate the forearm against your resistance. Increased pain in the bicipital groove confirms this condition.

Acromioclavicular Arthritis
Acromioclavicular arthritis is not a common cause of shoulder pain. When present, it usually is the result of direct injury to the shoulder girdle with resulting degenerative changes. Tenderness is localized over the acromioclavicular joint. Although motion in the glenohumeral joint is not painful in acromioclavicular arthritis, as it is in many other painful conditions of the shoulder, movements of the scapula, such as shoulder shrugging, are.

Adhesive Capsulitis (Frozen Shoulder)
Adhesive capsulitis refers to a mysterious fibrosis of the glenohumeral joint capsule, manifested by diffuse, dull, aching pain in the shoulder and progressive restriction of active and passive range of motion, but usually no localized tenderness. The condition is usually unilateral and occurs in persons aged 50 to 70. There is often an antecedent painful disorder of the shoulder or possibly another condition (such as myocardial infarction) that has decreased shoulder movements. The course is chronic, lasting months to years, but the disorder often resolves spontaneously, at least partially.
TABLE 15-5 ■ Swollen or Tender Elbows

Olecranon Bursitis
Swelling and inflammation of the olecranon bursa may result from trauma or may be associated with rheumatoid or gouty arthritis. The swelling is superficial to the olecranon process.

Arthritis of the Elbow
Swelling in the groove between the olecranon process and the epicondyles on either side can be palpated. Palpate for a boggy, soft, or fluctuant swelling and for tenderness.

Olecranon Bursitis

Arthritis

Epicondylitis
Lateral epicondylitis (tennis elbow) follows repetitive extension of the wrist or pronation-supination of the forearm. Pain and tenderness develop at the lateral epicondyle where the extensor origin is attached. When the patient resists wrist flexion and the wrist is maintained in a flexed position, pain occurs. Wrist flexion against resistance increases the pain.

Medial epicondylitis (pitcher’s, golfer’s, or Little League elbow) follows repetitive wrist flexion. Tenderness is maximal at the medial epicondyle. Wrist flexion against resistance increases the pain.

Rheumatoid Nodules
Subcutaneous nodules may develop at pressure points along the extensor surfaces of the elbow in patients with rheumatoid arthritis. They are firm and nontender, and are not attached to the overlying skin. They may or may not be attached to the underlying periosteum. Although they may develop in the area of the olecranon bursa, they often occur more distally.
<table>
<thead>
<tr>
<th>TABLE 15-6  Swellings and Deformities of the Hands</th>
</tr>
</thead>
</table>

**Osteoarthritis (Degenerative Joint Disease)**

- Nodules on the dorsolateral aspects of the distal interphalangeal joints (Heberden's nodes) are due to the bony overgrowth of osteoarthritis. Usually hard and painless, they affect the middle-aged or elderly and often, although not always, are associated with arthritic changes in other joints. Flexion and deviation deformities may develop. Similar nodules on the proximal interphalangeal joints (Bouchard's nodes) are less common. The metacarpophalangeal joints are spared.

  - Radial deviation of distal phalanx
  - Heberden's node
  - Bouchard's node
  - Metacarpophalangeal joints uninvolved

**Acute Rheumatoid Arthritis**

- Tender, painful, stiff joints characterize rheumatoid arthritis. Symmetric involvement on both sides of the body is typical. The proximal interphalangeal, metacarpophalangeal, and wrist joints are frequently affected; the distal interphalangeal joints are rarely so. Patients with acute disease often have fusiform or spindle-shaped swelling of the proximal interphalangeal joints.

  - tendon, swollen

**Chronic Rheumatoid Arthritis**

- As the arthritic process continues and worsens, chronic swelling and thickening of the metacarpophalangeal and proximal interphalangeal joints appear. Range of motion becomes limited and the fingers may deviate toward the ulnar side. The interosseous muscles atrophy. The fingers may show "swan neck" deformities (i.e., hyperextension of the proximal interphalangeal joints with fixed flexion of the distal interphalangeal joints). Less common is a boutonnière deformity (i.e., persistent flexion of the proximal interphalangeal joint with hyperextension of the distal interphalangeal joint).

  - Boutonnière deformity
  - Swan neck deformity

Rheumatoid nodules may accompany either the acute or the chronic stage.

* (table continues next page)
### TABLE 15-6  Swellings and Deformities of the Hands (Continued)

<table>
<thead>
<tr>
<th>Chronic Tophaceous Gout</th>
<th>Ganglion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Swollen</strong> The deformities that develop in long-standing chronic tophaceous gout can sometimes mimic those of rheumatoid and osteoarthritis. Joint involvement is usually not so symmetric as in rheumatoid arthritis. Acute inflammation may be present. Knobby swellings around the joints sometimes ulcerate and discharge white chalklike urates.</td>
<td><strong>Ganglion</strong> Ganglia are cystic, round, usually nontender swellings located along tendon sheaths or joint capsules. The dorsum of the wrist is a frequent site of involvement. Flexion of the wrist makes ganglia in this location more prominent; extension tends to obscure them. Ganglia may also develop elsewhere on the hands, wrists, ankles, and feet.</td>
</tr>
<tr>
<td>Draining tophus</td>
<td>Cystic swelling</td>
</tr>
<tr>
<td>Knobby swelling</td>
<td></td>
</tr>
</tbody>
</table>

#### Tendon Sheath and Palmar Space Infections

<table>
<thead>
<tr>
<th>Acute Tenosynovitis</th>
<th>Acute Tenosynovitis and Thenar Space Involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pain on extension</strong></td>
<td><strong>Puncture wound</strong></td>
</tr>
<tr>
<td>Swelling and tenderness along tendon sheath</td>
<td>Tender, swollen</td>
</tr>
<tr>
<td>Finger held in slight flexion</td>
<td></td>
</tr>
</tbody>
</table>

Infection of the flexor tendon sheaths (acute tenosynovitis) may follow local injury, even of apparently trivial nature. Unlike in arthritis, tenderness and swelling develop not in the joint but along the course of the tendon sheath, from the distal phalanx to the level of the metacarpophalangeal joint. The finger is held in slight flexion; attempts to extend it are very painful.

If the infection progresses, it may escape the bounds of the tendon sheath to involve one of the adjacent fascial spaces within the palm. Infections of the index finger and thenar space are illustrated. Early diagnosis and treatment are important.
TABLE 15-6  Swellings and Deformities of the Hands

**Felon**
- Injury to the fingertip may result in infection in the enclosed fascial spaces of the finger pad. Severe pain, localized tenderness, swelling, and dusky redness are characteristic. Early diagnosis and treatment are important.

**Trigger Finger**
- A trigger finger is caused by a painless nodule in a flexor tendon in the palm, near the head of the metacarpal. The nodule is too big to enter easily into the tendon sheath when the person tries to extend the fingers from a flexed position. With extra effort or assistance, the finger extends with a palpable and audible snap as the nodule pops into the tendon sheath. This snap may also be evident during flexion. Watch and listen as the patient flexes and extends the fingers, and feel for both the nodule and the snap.

**Dupuytren’s Contracture**
- The first sign of a Dupuytren’s contracture is a thickened plaque overlying the flexor tendon of the ring finger and possibly the little finger at the level of the distal palmar crease. Subsequently, the skin in this area puckers, and a thickened fibrotic cord develops between palm and finger. Flexion contracture of the fingers may gradually ensue.

**Thenar Atrophy**
- Muscular atrophy localized to the thenar eminence suggests a disorder of the median nerve or its components. Pressure on the nerve at the wrist is a common cause (carpal tunnel syndrome). Hypothenar atrophy suggests an ulnar nerve disorder.
TABLE 15-7 ■ Abnormalities of the Feet and Toes

Acute Gouty Arthritis
The metatarsophalangeal joint of the great toe may be the first joint involved in acute gouty arthritis. It is characterized by a very painful and tender, hot, dusky red swelling that extends beyond the margin of the joint. It is easily mistaken for a cellulitis. Acute gout may also involve the dorsum of the foot.

Hallux Valgus
In hallux valgus, the great toe is abnormally abducted in relationship to the first metatarsal, which itself is deviated medially. The head of the first metatarsal may enlarge on its medial side, and a bursa may form at the pressure point. This bursa may become inflamed.

Flat Feet
Signs of flat feet may be apparent only when the patient stands, or they may become permanent. The longitudinal arch flattens so that the sole approaches or touches the floor. The normal concavity on the medial side of the foot becomes convex. Tenderness may be present from the medial malleolus down along the medial-plantar surface of the foot. Swelling may develop anterior to the malleoli. Inspect the shoes for excess wear on the inner side of the soles and heels.

Ingrown Toenail
The sharp edge of a toenail may dig into and injure the lateral nail fold, resulting in inflammation and infection. A tender, reddened, overhanging nail fold, sometimes with granulation tissue and purulent discharge, results. The great toe is most often affected.

Hammer Toe
Most commonly involving the second toe, a hammer toe is characterized by hyperextension at the metatarsophalangeal joint with flexion at the proximal interphalangeal joint. A corn frequently develops at the pressure point over the proximal interphalangeal joint.

Corn
A corn is a painful conical thickening of skin that results from recurrent pressure on normally thin skin. The apex of the cone points inward and causes pain. Corns characteristically occur over bony prominences (e.g., the 5th toe). When located in moist areas (e.g., at pressure points between the 4th and 5th toes), they are called soft corns.
<table>
<thead>
<tr>
<th>Abnormalities of the Feet and Toes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Callus</strong></td>
</tr>
<tr>
<td>Like a corn, a callus is an area of greatly thickened skin that develops in a region of recurrent pressure. Unlike a corn, however, a callus involves skin that is normally thick, such as the sole, and is usually painless. If a callus is painful, suspect an underlying plantar wart.</td>
</tr>
<tr>
<td><strong>Plantar Wart</strong></td>
</tr>
<tr>
<td>A plantar wart is a common wart (verruca vulgaris) located in the thickened skin of the sole. It may look somewhat like a callus or even be covered by one. Look for the characteristic small dark spots that give a stippled appearance to a wart. Normal skin lines stop at the wart’s edge.</td>
</tr>
<tr>
<td><strong>Neuropathic Ulcer</strong></td>
</tr>
<tr>
<td>When pain sensation is diminished or absent (as in diabetic neuropathy, for example), neuropathic ulcers may develop at pressure points on the feet. Although often deep, infected, and indolent, they are painless. Callus formation about the ulcer is diagnostically helpful. Like the ulcer itself, it results from chronic pressure.</td>
</tr>
</tbody>
</table>