

Definition

Table 164.1 lists abnormalities that may be discovered in the musculoskeletal system. If abnormalities are detected in the musculoskeletal examination, there are several questions that the examiner should keep in mind while collecting and recording the data:

Is the problem a local one or are many areas involved?

Is the problem symmetrical?

Is the functional abnormality due to:

- A defect in the forces acting on the joint?
- A defect in the fulcrum (joint) itself?

Are there systemic manifestations (e.g., rash, fever)?

Technique

In examining the musculoskeletal system it is important to keep the concept of function in mind. Note any gross ab-

normalities of mechanical function beginning with the initial introduction to the patient. Continue to observe for such problems throughout the interview and the examination.

On a screening examination of a patient who has no musculoskeletal complaints and in whom no gross abnormalities have been noted in the interview and general physical examination, it is adequate to inspect the extremities and trunk for observable abnormalities and to ask the patient to perform a complete active range of motion with each joint or set of joints.

If the patient presents complaints in the musculoskeletal system or if any abnormality has been observed, it is important to do a thorough musculoskeletal examination, not only to delineate the extent of gross abnormalities but also to look closely for subtle anomalies.

To perform an examination of the muscles, bones, and joints, use the classic techniques of inspection, palpation, and manipulation. Start by dividing the musculoskeletal system into functional parts. With practice the examiner will establish an order of approach, but for the beginner it is perhaps better to begin distally with the upper extremity, working proximally through the shoulder. Then, beginning with the temporomandibular joint, pass on to the cervical spine, the thoracic spine, the lumbar and sacral spine, and the sacroiliac joints. Finally, in the lower extremity, again begin distally with the foot and proceed proximally through the hip.

Use the opposite side for comparisons: it is easier to spot subtle differences as well as identify symmetrical problems. If there is any question, use your own anatomy as a control.

Glean the maximum information from observation. Concentrating on one area at a time, inspect the area for discoloration (e.g., ecchymoses, redness), soft tissue swelling, bony enlargement, wasting, and deformity (abnormal angulation, subluxation). While noting these changes, attempt to determine whether they are limited to the joint or whether they involve the surrounding structures (e.g., tendons, muscles, bursae).

Observe the patient's eyes while palpating the joints and the surrounding structures. A patient's expression of pain depends on many factors. For this reason the verbalization of pain often does not correlate directly with the magnitude of the pain. The most objective indicator of the magnitude of tenderness produced by presence on palpation is involuntary muscle movements about the eyes. Therefore, the examiner should observe the patient's eyes while palpating the joints and surrounding structures. With practice the examiner will become skilled in evaluating the magnitude of pain produced by the examination and will be able to do a skillful evaluation without producing excessive discomfort to the patient. Note areas of tenderness to pressure, and if possible identify the anatomic structures over which the tenderness is localized.

One should also note areas of enlargement while palpating the joints and surrounding structures. By noting

Table 164.1
Summary of Information Seen on Musculoskeletal Examination

Skin
Color change
Consistency
Sweating or coldness
Eruptions
Ulcerations
Heat
Soft tissue swelling
Synovial thickening
Periarticular swelling
Nodules
Effusion
Wasting (atrophy, dystrophy, spasm, contracture)
Tenderness to palpation and pain on motion
Crepitation
Deformity
Abnormal angulation
Subluxation
Limitation of motion
Stability
Abnormalities of trunk and spine
Scoliosis
Kyphosis
Limitation of motion
Flexion (mostly easily documented by measuring lengthening)
Lateral flexion
Rotation
Ambulation
Ability to ambulate with or without aids
Gait

carefully the consistency of the enlargement and its boundaries, one can decide whether this is due to bony widening, thickening of the synovial lining of the joint, soft tissue swelling of the structure surrounding the joint, an effusion into the joint capsule, or nodule formation, which might be located in a tendon sheath, subcutaneous tissue, or other structures about the joint.

While palpating the joints, note areas of increased warmth (heat). A method for doing this that will help even the most inexperienced to perceive subtle increases in heat is to choose the most heat-sensitive portion of the hand (usually the dorsum of the fingers) and, beginning proximally, lightly pass this part of your hand over all portions of the patient's extremity several times. As you proceed from proximal to distal, the skin temperature gradually cools. If you find an area becoming slightly warmer, this represents increased heat.

Have the patient perform active movements through an entire range of motion for each joint. Defects in function can be most rapidly perceived by having the patient perform active functions with each region of the musculoskeletal system. This reduces examination time and helps the examiner to identify areas in which there is poor function for more careful evaluation.

Manipulate the joint through a passive range of motion only if the patient is unable actively to perform a full range of motion, or if there is obvious pain on active motion. In passively manipulating a joint, note whether there is a reduction in the range of motion, whether there is a pain on motion, and whether crepitus is produced when the joint is moved. Note also whether the joint is stable or whether abnormal movements may be produced.

Upper Extremity

Observe and palpate both *hands and wrists*, noting areas of color change, enlargement, and temperature change (described elsewhere). Also note deformities if present (contractures, subluxations, abnormal angulations). Look carefully for nail and cuticle abnormalities, atrophy of the thenar or hypothenar eminences, and triggering. Triggering in a finger is caused by an inflammatory nodule within a tendon sheath. It is characterized by an inability to extend a finger until a larger than usual force is applied along the flexor tendon sheath and the finger snaps into extension. Ask the patient to make a tight fist with both hands. Ask the patient to grasp a small object such as a finger. If the patient is capable of making a tight fist and grasping a small object with no observable abnormality, then a passive manipulation of the metacarpophalangeal joints and proximal and distal interphalangeal joints need not be made; however, should an abnormality be detected, passive examination of the range of motion of each of the joints should be performed.

Normal range of motion for the fingers:

- Distal interphalangeal joints (digits 2–5): 0 to 80 degrees of flexion
- Proximal interphalangeal joints (digits 2–5): 9 to 120 degrees of flexion
- Interphalangeal joint of the thumb: 35 degrees hyperextension, 90 degrees flexion
- Metacarpophalangeal joints (digits 3–5): 30 degrees hyperextension, 90 degrees flexion

- Metacarpophalangeal joint of the thumb: 0 to 70 degrees of flexion

To examine range of motion of the wrist, ask the patient to assume an attitude with the elbows flexed and the forearms parallel to the floor, and then press the palms of the hands and the dorsum of the hands as closely together as possible, producing angulation of the wrist. The wrist can normally be dorsiflexed to 70 degrees and palmar flexions should be possible to approximately 80 or 90 degrees. Ask the patient to deviate the hand ulnarward; this should be possible to 50 to 60 degrees. Finally, ask the patient to deviate both hands radialward; this should be possible to approximately 20 degrees.

Observe and palpate both *elbows* and over the olecranon process, again noting areas of color change and enlargement. Be careful to observe for synovial thickening or effusion both in the joint itself and in the area of the olecranon bursa. Observe for subcutaneous nodules over the olecranon process. Ask the patient to extend both elbows fully and to flex them fully. The position of full extension is designated as 0 degrees, and flexion should be performed well to 160 degrees in the normal state.

The range of motion in the radiohumeral joints is then tested by asking the patient to pronate and supinate both hands fully. In the normal state the palm of the hand should be able to be placed flat on a table in pronation and the dorsum of the hand flat on the table in supination.

The examination of the *shoulder* is best performed with the patient sitting or standing in such a position that the examiner can move freely about the patient's body. Range of motion of the shoulder should be examined with and without manual fixation of the shoulder.

The shoulder mechanism is a complicated system where several joints act in concert. The physician should be familiar with the anatomy of the shoulder and of the contiguous structures that act together. These include the glenohumeral joint, the acromioclavicular joint, the sternoclavicular joint, the gliding tissue space between the scapula and thorax, the shoulder capsule or rotator cuff, and the subacromial bursa.

The sternoclavicular joint, the acromioclavicular joint, the scapulae, and shoulders are inspected for enlargement, wasting, and color changes. Carefully palpate these areas, then the shoulder joints around the margin of the shoulder capsule. If swelling or tenderness is encountered, it is important to attempt to localize the responsible structure. This is most easily done by referring to an atlas on the anatomy of the shoulder.

Forward flexion is then checked by asking the patient to flex the shoulders fully frontward. This should be possible to 90 degrees or parallel to the floor when the patient is standing or sitting erect. Ask the patient to rotate and to continue to flex the shoulders, placing both hands together over the head with arms parallel to and against the ears. This should be possible in the normal state to 180 degrees. Ask the patient to abduct both shoulders, which should again be possible to 90 degrees, and to rotate and further abduct the shoulders touching both hands together over the head with the upper arms tightly pressed against the ears.

Ask the patient to clasp both hands behind the occiput to check for external rotation. Ask the patient to spread both elbows wide apart, then to release the handclasp but maintain the flexion of the elbows and touch the elbows together in front of the head.

The patient is then asked to elevate both shoulders as if

shrugging them. In this instance it is difficult to describe specific angles and motion, but the examiner will gain experience in detecting abnormalities.

The *temporomandibular joints* are inspected and palpated as described previously for other joints. Continue to palpate the temporomandibular joints while asking the patient to open and close the mouth and to move the jaw from side to side. Again, it is very difficult to describe a specific range of motion, but experience will help in detecting abnormalities. Palpate and listen for crepitation while the motion is being performed.

Spine

Inspect the *cervical spine* for loss of the normal lordotic curve. Palpate for local areas of tenderness and crepitation. Next, ask the patient to put the chin on the chest to check flexion, to put first the right ear on the right shoulder and the left ear on the left shoulder for lateral flexion, and to extend the neck as far as possible by looking back over the ceiling as far as possible. Rotation is then checked by asking the patient to put the chin on the right shoulder and then the left shoulder.

Examine the *thoracic and lumbar spine* together. Examine the back and palpate for areas of muscle spasm and tenderness. Lightly percuss over the spinous processes throughout the spine to check further for tenderness. Observe the patient both standing and sitting from behind and from the side to check for kyphosis (an abnormal forward flexed position) and scoliosis (an abnormal curvature of the spine on one side or the other). The presence of scoliosis can best be judged by determining if a list is present. If the first thoracic vertebra is not centered over the sacrum, the patient is said to have a list. This can easily be measured by dropping a perpendicular from the first thoracic vertebra and measuring how far to the right or left of the gluteal fold it falls. If a list is demonstrated, scoliosis must be present. Also observe whether the lumbar lordosis is present in increased amount or abnormally absent.

Check for forward flexion in the sitting position by asking the patient to place the nose on the knee, and in the standing position by asking the patient to touch the toes. To check for lateral flexion, ask the patient to hyperextend the spine as much as possible and then to pass the hand straight down the thigh, first on the right and then on the left, keeping the hips straight. Ask the patient to maintain the pelvic girdle in a flexed position and rotate the shoulders first to the right and then to the left to check for rotation. With the patient standing, check for a pelvic tilt by placing your hands on the iliac crests and observing if these are parallel. Angles of motion can be estimated from an imaginary line passing straight up through the spine, perpendicular to the floor or to the table. It is very difficult to measure these accurately or to list accurate normal measurements. The most accurate parameter of measurement is the amount of lengthening of the spine in forward flexion. The normal spine should lengthen more than 5 cm in the thoracic area and more than 7.5 cm in the lumbar area on forward flexion.

Costovertebral joint motion can be measured by placing the hands with fingers spread on the thorax and having the patient inspire and expire fully. If there is an abnormality, an accurate measurement of chest expansion at the nipple line should be recorded as a baseline.

For *straight leg raising tests*, ask the patient to lie with the spine on the table and to relax completely. With the knee fully extended, first one leg and then the other is slowly lifted and flexed at the hip. This produces stretch on the sciatic nerve, at which point sciatic pain is produced. If this maneuver produces pain in the hip or low back with radiation in the sciatic area, the test is considered positive for nerve root irritation. The angle of elevation of the leg from the table at the point where pain is produced should be recorded.

The *sacroiliac joints* are examined by palpation and by light fist percussion for tenderness. Other maneuvers that might produce pain in a sacroiliac joint when inflammation is present are:

- **Compression of the iliac crests:** This is performed by asking the patient to lie on his or her side, placing firm downward pressure on the upper iliac crest. If pain is produced by this maneuver in a sacroiliac joint, this can aid diagnosis; but the absence of pain does not rule out involvement of the sacroiliac joint.
- **Jarring the sacroiliac joint:** The patient is asked to lie on his or her side, facing the examiner. The inferior leg is flexed at the hip and knee, and the upper leg is fully extended. Place your hand on the upper iliac crest and produce a sharp jar on the patient's flexed knee with the palm of your hand. Again, pain in a sacroiliac joint is considered a positive test, but a negative test does not rule out possible involvement of a sacroiliac joint.
- **Passive hyperextension of the lower extremity:** Ask the patient to move close to the edge of the examining table in the supine position. With the patient fully relaxed, the examiner supports a lower extremity and slowly allows it to hyperextend passively over the side of the examining table.

Lower Extremity

The *feet* are inspected for abnormal coloration and localized areas of swelling. Note should be taken of skin lesions about the feet and toes. Palpate and record arterial pulsations (dorsalis pedis and posterior tibial). In addition, observe for lowering of the longitudinal arch (*pes planus*, or flat foot), abnormal elevation of the longitudinal arch (*pes cavus*), abnormal angulation of the first metatarsophalangeal joint (*hallux valgus*), hammertoe or cock-up deformities of the toes, and the formation of callouses or bursae over the pressure areas. Ask the patient to perform flexion and extension of the toes actively. If there appears to be an abnormality, each toe must be passively put through a range of motion. Mobility of the midtarsal joints is measured by grasping the foot with both hands and gently rotating the hands in opposite directions.

Examine the *ankle* for discoloration and swelling and palpate for tenderness, swelling, effusion, and crepitus on range of motion. Ask the patient to dorsiflex the ankles (this should be possible to approximately 20 degrees) and to plantar-flex the ankles (this should be possible to approximately 45 degrees). Then ask the patient to invert (*supinate*) the ankle, which should be possible to 30 degrees, and to evert (*pronate*) the ankle, which should be possible to 20 degrees.

Ask the patient to stand and walk. Note attitudes of pron-

ation or supination and toeing in and toeing out with walking.

The *knee*, the largest joint in the body, is a compound condylar joint. The specific anatomy of the knee should be reviewed. Inspect the knees for discoloration, swelling, and deformities and note whether they are laterally angulated (*genu varum*) or medially angulated (*genu valgum*). In addition, note a backward bowing of the knee (*genu recurvatum*) and lack of full extension of the knee (flexion contracture). The abnormalities mentioned on inspection up to this point are best noted with the patient standing and weight-bearing.

The remainder of the examination of the knees is best done with the patient supine. Look for atrophy of the quadriceps muscles and observe the contour of the knees. In palpating a knee that appears swollen, attempt to identify the structures producing the enlargement.

Synovial thickening, as in chronic synovitis, produces a swelling of doughy consistency. This can best be perceived as a thickening of the synovial edge as it reflects in the suprapatellar pouch. It is noted as a longitudinal ridge approximately 4 to 5 cm above the upper border of the patella.

Fluid or effusion in the knee is perceived in two fashions:

1. Use the left hand to compress the reflection of the joint capsule beneath the quadriceps tendon and the fingers of the left hand cupped around the lateral margin of the joint to compress the fluid if present beneath the patella. Then use the right hand to exert downward pressure on the patella, producing a ballottement and a click as the patella strikes the femoral condyles.
2. Small amounts of fluid can be perceived by producing pressure on the lateral surface of the joint in a stroking fashion to express fluid if present to the medial portion of the joint. Pressure is then placed on the medial portion of the joint to produce a fluid bulge as the fluid is expressed back into the lateral portion. This same maneuver can be performed by stroking the medial surface to express the fluid and producing the bulge on the medial surface.

With the left hand held firmly over the patella, ask the patient to flex and extend the knee slowly. In performing this maneuver, note the angles of extension and flexion and whether or not crepitus is present as the joint moves. Extension should be full to 180 degrees or 0 degrees, and flexion should be possible to 130 degrees. If there is a limitation in this range, then these motions should be performed passively by the examiner with the patient relaxed in order to delineate the cause of the limitation.

Stability of the knee should be determined by the following maneuvers:

1. Lateral stability is checked by asking the patient to extend the knee fully, grasping the inside lower end of the femur with the left hand and the tibia just above the ankle with the right hand. Attempt to adduct the tibia on the femur in a rocking motion. In the normal state this is not possible. To test for medial stability, grasp the outer lower end of the femur with the left hand and the tibia just above the ankle with the right hand. Attempt to abduct the tibia on the femur with a rocking motion. In the normal state this is not possible. The angles to which the tibia can be abducted

or adducted should be estimated or accurately measured using a goniometer.

2. Integrity of the cruciate ligaments is tested by the drawer sign. Ask the patient to flex the knee to 90 degrees. Holding the femur in a fixed position, attempt to pull and push the tibia forward and backward on the femur. Normally one should have very little motion on this maneuver; ability to pull the tibia forward on the femur indicates a defect in the anterior cruciate, whereas the ability to push the tibia back on the femur indicates a defect in the posterior cruciate.

The *hip* is a ball-and-socket joint and consequently capable of complex motions of flexion, extension, abduction, adduction, and rotation. A number of specialized tests can be performed about the hip to delineate specific abnormalities. These will not be discussed exhaustively in this section. Should an abnormality be observed in the standard routine examination, refer to a good orthopedic or rheumatology textbook such as those listed in the references.

The patient is observed in a standing position for tilt of the pelvis, as noted above in the spinal examination. A tilt may be due to disease of the hip or to unequal leg length. The gait is observed to detect a limp that might be secondary to pain in the hips, or limitation of motion due to structural damage to the joint itself or to the musculature and innervation about the joint.

Ask the patient to lie supine on the table and to actively flex first one hip and then the other with the opposite hip fully extended. Flexion with the knee straight should be possible to 90 degrees and, with the knee bent, to 120 degrees or greater.

Tests for abduction of the hip are easier to perform passively. Place the left hand on the crest of the ilium and grasp the right leg with the right hand. Gradually abduct the leg as far as possible without producing motion of the pelvis. Abduction should be possible to 40 degrees or greater. Perform the same maneuver on the left leg.

Rotation may be measured with both the knee and the hip flexed at 90 degrees. The opposite leg should be fully extended. Internal rotation is measured by moving the ankle outward, which should be possible to 40 degrees. External rotation is measured by moving the ankle inward, which should be possible to 45 degrees or greater. Rotation of the hip may also be measured with the patient lying prone on the table and the hip fully extended. In this case the knee on the side being measured should be flexed to 90 degrees and fully extended on the opposite side.

Flexion contracture of the hip is detected by flexing the opposite hip until the lumbar lordosis is flattened on the table. Ask the patient to cooperate in this examination by holding the flexed knee. The leg on the side of the hip being examined is then slowly lowered to the table. If a contracture exists, this maneuver cannot be performed completely.

Hyperextension of the hip can be checked by asking the patient to lie prone on the table and slowly lifting the leg being examined; this should be possible to 15 degrees or greater.

Basic Science

The musculoskeletal system is composed of muscles, bones, joints, and the other connective tissue components that join

Table 164.2
Common Problems in the Musculoskeletal System

Inflammatory arthritis (e.g., rheumatoid arthritis, seronegative spondyloarthropathies)

Observation and palpation:

- Redness (may not be present if inflammation is mild)
- Swelling due to synovial thickening (may be inflammatory effusion)

Heat

Tenderness

Functional:

Limitation of motion due to pain

Additional data if problem has been present for a long time (as in the nonspecific inflammatory arthritides such as rheumatoid arthritis):

Pain

Observation and palpation: Deformity due to subluxation may be present

Functional:

Motion may be limited due to:

- Fibrous contractures of the periarticular soft tissues
- Joint destruction

Joint may be unstable due to:

- Destruction of cartilage and bone
- Rupture of tendon(s)

Degenerative joint disease (osteoarthritis)

Observation and palpation:

- Redness and increased warmth may be present if joint is secondarily inflamed due to trauma
- No palpable synovial thickening
- Effusion may be present
- Bony enlargement at joint margins
- Heberden's nodes on distal interphalangeal joints of fingers
- Tenderness frequently over tendon insertions and bursae about joints

Functional:

- Pain on motion
- Palpable crepitus on passive motion
- Instability frequently due to loss of cartilage and loosening of capsule

Traumatic arthritis

Observation and palpation:

- May be ecchymosis
- Soft tissue swelling (depending on severity of trauma may involve periarticular tissue or may be limited to effusion within joint capsule)
- Tenderness to pressure

Functional:

- Motion limited due to pain
- Instability if trauma sufficient to tear tendon(s) or joint capsule

Primary muscle disease

Observation and palpation:

- Swelling of muscles may be present
- Tenderness to pressure over body of muscle may be present

Functional: Impairment of function due to muscle weakness; in the case of inflammatory muscle disease (polymyositis or dermatomyositis), weakness more pronounced proximally than distally

these structures. Taken as a whole, the musculoskeletal system is the mechanism by which the body performs all mechanical functions. Each joint is designed to perform a specific set of motions, and there is a complicated system of muscles, tendons, bursae, etc., to produce and facilitate delivery of the mechanical forces acting around the fulcrum (the joint) to effect the desired function. An abnormality in any of these structures will produce a malfunction.

Clinical Significance

Some of the most common problems in the musculoskeletal system as well as some characteristics that are helpful in arriving at a correct diagnosis are listed in Table 164.2.

References

- Anson BJ. An atlas of human anatomy. 2nd ed. Philadelphia: W.B. Saunders, 1963.
- Anson BJ, Maddock WG. Callander's surgical anatomy. 4th ed. Philadelphia: W.B. Saunders, 1971.
- Basmajian JV, ed. Grant's method of anatomy. 7th ed. Baltimore: Williams and Wilkins, 1980.
- Clemente CD, ed. Gray's anatomy of the human body. 30th ed. Philadelphia: Lea & Febiger, 1985.
- Kelly WN, Harris ED, Ruddy S, Sledge CB. Textbook of rheumatology. Philadelphia, London, and Toronto: W.B. Saunders, 1981.
- McCarty DJ, ed. Arthritis and allied conditions. 10th ed. Philadelphia: Lea & Febiger, 1985.
- Polly HF, Hunder GG. Rheumatologic interviewing and physical examination of the joints. 2nd ed. Philadelphia: W.B. Saunders, 1978.
- Scott JT, ed. Copeman's textbook of the rheumatic diseases. London and New York: Churchill Livingstone, 1986.