# Therapeutic Exercise

## Foundations and Techniques

FIFTH EDITION

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# Management of Vascular Disorders of the Extremities

24 CHAPTER



Vascular disorders causing insufficient circulation to the extremities, can result in significant physical impairments and subsequent loss of function of either the upper or lower extremities. Disturbances of structure or function of the circulatory systems are broadly classified as acute or chronic *peripheral vascular disease* (PVD) and can be caused by a number of underlying pathologies of the arterial, venous, or lymphatic systems, including occlusion, inflammation, vasomotor dysfunction, or neoplasms.[33,38,46] In addition, surgical procedures or radiation therapy necessary for the treatment of some forms of cancer can impair lymphatic circulation.[5,39,63,68]

To contribute to the effective management of patients with vascular disorders, a therapist must possess a sound understanding of the underlying pathologies and the clinical manifestations of many types of arterial, venous, and lymphatic disorders. A therapist must also be aware of the use, effectiveness, and limitations of therapeutic exercise in the comprehensive management and rehabilitation of patients with vascular disorders.

## Disorders of the Arterial System

### Types of Arterial Disorders

#### Acute Arterial Occlusion

A thrombus (blood clot), embolism, or trauma can cause acute loss of blood flow to peripheral arteries. The most common location of an arterial embolus is at the femoral-popliteal bifurcation, although an embolus can occur at

other arterial bifurcations in the extremities.[33,38] Crush injuries to the vessels of the extremities also can disrupt arterial blood flow and must be repaired quickly to restore circulation and prevent tissue necrosis. If a patient develops an acute arterial occlusion, immediate medical or surgical measures must be taken to maintain the viability of the limb. These measures could include complete bed rest, systemic anti-coagulation therapy, thromboembolectomy, or reconstructive arterial bypass surgery.[27,33,54]

PRECAUTION: With an acute occlusion therapeutic exercise is contraindicated. Use of support hose or application of direct heat over painful areas also is contraindicated.[54]

### Arteriosclerosis Obliterans

Arteriosclerosis obliterans (ASO), also called *chronic occlusive arterial disease*, *peripheral arterial occlusive disease*, or *atherosclerotic occlusive disease*, accounts for 95% of all the arterial disorders affecting the lower extremities.[33] It is a chronic disorder, most often seen in elderly patients. ASO is more common in men than women and is associated with risk factors that include elevated serum cholesterol (> 200 mg/dL), smoking, high systolic blood pressure, obesity, and diabetes.[13,33,35,66]

ASO is characterized by chronic, progressive occlusion of the peripheral circulation, most often in the large and medium arteries of the lower extremities. It is caused by atherosclerotic plaque formation.[33,66]

### Thromboangiitis Obliterans (Buerger's Disease)

Thromboangitis obliterans is a chronic disease seen predominantly in young male patients who smoke; it involves an inflammatory reaction of the arteries to nicotine. Initially, it becomes evident in the small arteries of the feet and hands and progresses proximally. It results in vasoconstriction, decreased arterial circulation to the extremities, ischemia, and eventual ulceration and necrosis of soft tissues.[27,38,46] The inflammatory reaction and resulting signs and symptoms can be controlled if the patient stops smoking.

### Raynaud's Disease

Raynaud's disease, also known as *primary Raynaud's syndrome*, is a chronic, functional arterial disorder that occurs more often in women than men. Thought to be caused by an abnormality of the sympathetic nervous system, it is characterized by digital vasospasm, most often affecting the small arteries and arterioles of the fingers and sometimes the toes. Vasospasm is brought on by exposure to cold, vibration, or stress. The response is characterized by temporary pallor (blanching), then cyanosis and pain, followed by numbness and a cold sensation of the digits. Symptoms are relieved slowly by warmth.[27,33,38,46,54]

When the disorder is primary, it is called *idiopathic Raynaud's disease* or *Raynaud's syndrome.* When it is a secondary complication and associated with another disease (such as scleroderma, systemic lupus erythematosus, systemic sclerosis, or vasculitis), it is called *Raynaud's phenomenon.*[46,78]

## Clinical Manifestations of Peripheral Arterial Disorders

The following signs and symptoms are associated with peripheral arterial disorders.

### Diminished or Absent Peripheral Pulses

The more occluded or restricted the arterial blood flow and the more diminished the peripheral pulses, the more severe or advanced is the arterial disease.[27,33,46,50,54] If the collateral circulation is extensive, the patient may not experience pain despite diminished pulses.

### Integumentary Changes

A number of integumentary changes are associated with peripheral arterial disease.[27,33,34,38,46,53,54]

- Skin discoloration, including *pallor* at rest or with exercise, or *reactive hyperemia* can develop. Pallor is more evident when the extremity is elevated above the level of the heart for several minutes. Reactive hyperemia occurs when the extremity is moved from an elevated to a dependent position. The skin takes on a bright red appearance rather than a normal pink flush. (Refer to the test for rubor of dependency in the following section.) Pallor of the distal extremity may also occur with exercise. After exercise, cutaneous ischemia causes blanching of the skin as arterial blood flow is diverted to the exercising muscles and away from the surface tissues of the distal extremity.
- *Trophic changes* include a shiny, waxy appearance and dryness of the skin and loss of hair distal to the occlusion.
- Skin temperature is decreased.
- *Ulcerations* may develop, particularly at weight-bearing areas or over bony prominences.

### Sensory Disturbances

Intolerance to heat or cold and paresthesia (initially tingling, then numbness) can develop.[27,46,54]

### Exercise Pain and Rest Pain

Pain during exercise and at rest is associated with progressive peripheral arterial disease and leads to significant disability.[27,34,35,46,54]

***Exercise pain.*** Pain that occurs and gradually increases with exercise is referred to as *intermittent claudication.*[13,27,30,32,46,54] It is experienced most common in the lower extremities and occurs more frequently and with greater intensity as the severity of chronic arterial insufficiency progresses. During the early stages of arterial disease, intermittent claudication is characterized by a feeling of fatigue or weakness and, later, as cramping or aching in the muscles used during exercise.

**TABLE 24.1 Common Sites of Exercise Pain and Associated Arterial Occlusion**

| Site of Pain | Occluded Artery |
|---|---|
| **Chronic arterial insufficiency** | |
| Calf | Femoral |
| Foot | Popliteal |
| Thigh | Iliac |
| Buttocks or low back | Aortic |
| **Thromboangiitis obliterans** | |
| Arch of the foot | Plantar and tibial |
| Palm of the hand | Palmar and ulnar |

Pain is located distal to the occluded vessels and is caused by insufficient blood supply and activity-induced ischemia in the exercising muscles. Leg pain typically is brought on by walking and gradually subsides when the patient stops walking. Intermittent claudication does not occur with extended periods of standing (as seen with spinal stenosis)[34] or with prolonged sitting (as seen with sciatica).[9,35]

Although exercise pain is most common in the calf, it also can occur more proximally. Table 24.1 identifies common sites of intermittent claudication.[9,27,33,34,46,54]

If peripheral vessels such as the popliteal, femoral, or iliac arteries are occluded, symptoms usually occur in one extremity; whereas if the occlusion is in the lower aorta, symptoms are present not only in both extremities but in the buttocks and low back regions as well. As the disease progresses and arterial insufficiency increases, exercise tolerance deteriorates as ischemic pain occurs more readily with activity.

***Rest pain.*** When a burning, tingling sensation gradually becomes evident in the distal extremities at rest or with elevation, it may be indicative of severe ischemia. With ischemia, pain frequently occurs at night because the heart rate and volume of blood flow to the extremities decreases with rest. Sometimes partial or complete relief of pain is possible if the leg is placed in a dependent position, such as over the edge of a bed. In contrast, elevation of the limb increases the pain.

### Muscle Weakness

Loss of strength, muscle atrophy, and eventual loss of motor function, particularly in the hands and feet, occur with progressive arterial vascular disease. Loss of motor function is compounded by pain, which further compromises functional strength.[27,54]

## Examination and Evaluation of Arterial Sufficiency

A comprehensive examination of a patient with known or suspected peripheral arterial disease is necessary to determine or verify the etiology of a patient's impairments and functional limitations. For example, the origin of a patient's buttock and leg pain or lower extremity weakness could be caused by vascular or neuromuscular pathologies.[34,35] The initial and subsequent examinations also provide a basis to determine a patient's status before treatment and the effectiveness of the interventions at the conclusion of treatment.

Various procedures for testing arterial sufficiency and identifying stenosis or occlusion are listed in Box 24.1 and described briefly in this section.[42,46,50,54] Some procedures are used by therapists to indirectly assess arterial blood flow, whereas others, such as angiography or arteriography, are administered by practitioners with specialized training and are interpreted by a physician.

### Palpation of Pulses

The basis of any evaluation of the integrity of the arterial system is the detection of pulses in the distal portion of the extremities. Pulses are described as *normal*, *diminished*, or *absent*. The strength of pulses also can be rated quantitatively from 0 to +3. Even if pulses appear normal, blood flow to the extremity may, in fact, be substantially restricted.[12] Pulselessness is a sign of severe arterial insufficiency.

The femoral, popliteal, dorsalis pedis, and posterior tibial pulses should be palpated in the lower extremities. The radial, ulnar, and brachial pulses are palpated in the upper extremities.

NOTE: Pulses are difficult to assess quantitatively by palpation alone. Other, more accurate and reliable noninvasive tests (such as Doppler ultrasonography) supplement the information gained from palpating the pulses.

### Skin Temperature

The temperature of the skin can be assessed grossly by palpation. A limb with diminished arterial blood flow is cool to the touch. If a discrepancy exists between an involved and an uninvolved extremity, skin temperature should be quantitatively measured with an electronic thermometer.

**BOX 24.1 Tests and Measurements of Arterial Sufficiency**

- Palpation and comparison of pulses in the involved and uninvolved upper or lower extremities
- Skin temperature
- Skin integrity and pigmentation
- Tests for reactive hyperemia (rubor of dependence)
- Claudication time
- Ultrasonography, Doppler measurement of blood flow, transcutaneous oximetry
- Magnetic resonance angiography
- Arteriography

### Skin Integrity and Pigmentation

Diminished or absent arterial blood flow to an extremity causes trophic changes in the skin peripherally. The patient's skin is dry, and its color is diminished (pallor). Hair loss and a shiny appearance to the skin also occur. Skin ulcerations may be present.

### Rubor Dependency Test—Reactive Hyperemia

Changes in skin color that occur with elevation and dependency of the limb as the result of altered blood flow are determined. Rubor/reactive hyperemia can be assessed in two ways.[42,46]

***Procedure.*** The legs are elevated for several minutes above the level of the heart while the patient is lying supine. Pallor (blanching) of the skin occurs in the feet within 1 minute or less if arterial circulation is poor. The time necessary for blanching to develop is noted. Then the legs are placed in a dependent position, and the color of the feet is noted.

Normally, a pinkish flush appears in the feet within several seconds after the legs are placed in a dependent position. With occlusive arterial disease, a bright bluish-red color, or rubor, of the distal legs and feet is evident that is caused by reduced blood flow in the capillaries. The rubor may take as long as 30 seconds to appear.

***Alternate procedure.*** Reactive hyperemia also can be evaluated by temporarily restricting blood flow to the distal portion of the lower extremity with a blood pressure cuff. This restriction causes an accumulation of $CO_2$ and lactic acid in the distal extremity. These metabolites are vasodilators and affect the vascular bed of the blood flow-deprived area.[12]

When the cuff is released and blood flow resumes to the distal extremity, a normal hyperemia (flushing) of the extremity should occur within 10 seconds. With arteriosclerotic vascular disease it may take as long as 1 to 2 minutes for a flush to appear, whereas with vasospastic arterial disease (Raynaud's disease) flushing occurs within the normal time frame.[12]

NOTE: This method of assessing reactive hyperemia is quite painful and is not tolerated well by either normal individuals or patients with occlusive arterial disease.

### Claudication Time

An objective assessment of exercise pain (intermittent claudication) is performed to determine the amount of time a patient can exercise before experiencing cramping and pain in the distal musculature.[30,46,66]

A commonly used test is to have the patient walk at a slow, predetermined speed on a level treadmill (1 to 2 mph). The time that the patient is able to walk before the onset of pain or before pain prohibits further walking is noted.[30,46] This measurement should be undertaken to determine a baseline for exercise tolerance before initiating a program to improve exercise tolerance.

### Doppler Ultrasonography

Doppler measurement of blood flow with ultrasound imaging is a noninvasive assessment that uses the Doppler principle to determine the relative velocity of blood flow in the major arteries and veins.[27,42,46,54] A soundhead, covered with coupling gel, is placed on the skin directly over the artery to be evaluated. An ultrasonic beam is directed transcutaneously to the artery. Blood cells moving in the path of the beam cause a shift in the frequency of the reflected sound.

The frequency of the reflected sound emitted varies with the velocity of blood flow. This information is transmitted visually onto an oscilloscope or printed tape or audibly via a loudspeaker or stethoscope.

### Transcutaneous Oximetry

Transcutaneous oximetry provides information about the oxygen saturation of blood by means of a photoelectric device (a pulse oximeter).[33] A beam of red and infrared light passes through a pulsating capillary bed (e.g., in the fingertip). The ratio of red to infrared transmission varies with the oxygen saturation of the blood. Because it responds only to pulsating objects, it does not detect nonpulsating objects, such as venous blood or skin.

### Arteriography

Arteriography is an invasive procedure that involves injecting a radiopaque dye (contrast medium) directly into an artery.[33,38,46] The arteries are then radiographically visualized to detect any restriction of movement of the dye in arterial vessels indicating a partial or complete occlusion. Collateral circulation can also be visualized. Because arteriography gives a highly accurate picture of the location and extent of an arterial obstruction, it is used most often prior to reconstructive arterial bypass surgery.

### Magnetic Resonance Angiography

Magnetic resonance angiography, a noninvasive procedure, provides radiographic visualization of arteries without the use of a contrast medium.[33]

## Management of Acute Arterial Occlusion

Acute arterial occlusion often is a medical or surgical emergency. The resulting ischemia causes severe pain, the risk of tissue necrosis and local or systemic infection, and the possible need for amputation. The viability of the limb depends on the location and extent of the occlusion and the availability of collateral circulation.

Medical or surgical measures must be taken to reduce ischemia and to restore circulation. Medical management includes bed rest and complete systemic anticoagulation therapy. Complementary physical interventions to improve peripheral blood flow while the patient is on bed rest may include warming the limb by reflex heating of the torso or opposite extremity or elevating the head of the bed slightly.[27,46] Several contraindications also are warranted (Box 24.2).

**BOX 24.2 Contraindications with Acute Arterial Occlusion**

- Exercise—passive or active
- Prolonged positioning during bed rest, which could cause pressure on and potential breakdown of skin
- Local, direct heat on the involved extremity because of the potential for a burn to the ischemic tissue
- Use of support hose, which may increase peripheral resistance to blood flow
- Restrictive clothing that could compromise blood flow

Surgical interventions for an acute occlusion are *thromboembolectomy* or an arterial bypass graft. If circulation cannot be significantly improved or restored, gangrene develops within a very short time, and amputation of the extremity is necessary.[33]

## Management of Chronic Arterial Insufficiency

Except with advanced disease, chronic arterial insufficiency caused, for example, by ASO or Raynaud's disease is managed conservatively by medical and physical means and does not constitute a medical or surgical emergency.[27,46,54,66] Box 24.3 summarizes management guidelines for chronic arterial insufficiency.

### Medical/Surgical Management

Medical management of chronic arterial insufficiency must be ongoing. Related medical disorders must be identified and treated. Diabetes and hypertension are commonly associated with chronic arteriosclerotic vascular disease and must be controlled with medication, diet, and exercise.[66]

Lifestyle changes are an important aspect of management. In all cases, patients are advised to stop smoking and alter their diet, such as limiting or avoiding salt, sucrose, and alcohol to lower blood pressure and triglyceride and

**BOX 24.3**
**MANAGEMENT GUIDELINES—Chronic Arterial Insufficiency**

**Impairments**

Decreased endurance and increased frequency of muscular fatigue with functional activities such as walking
Pain with exercise or at rest
Skin breakdown and ulcerations
Limitation of passive and active motion
Weakness and disuse atrophy

| Plan of Care | Interventions |
|---|---|
| 1. Teach the patient how to minimize or prevent potential impairments and correct impairments or functional limitations currently affecting functional capabilities. | 1. Self-management of current or potential impairments through patient education. |
| 2. Communicate with health professionals from other disciplines appropriate for consultation with the patient. | 2. Medical or surgical management including medications; nutritional counseling for weight control and to decrease salt, sucrose, cholesterol, and caffeine intake; smoking cessation. |
| 3. Improve exercise tolerance for ADL and decrease the incidence of intermittent claudication. | 3. Regular, graded aerobic conditioning program of walking or bicycling[30,46,54,65,66,79] (see Chapter 7). |
| 4. Relieve pain at rest. | 4. Sleep with the legs in a dependent but supported position over the edge of the bed or with the head of the bed slightly elevated. |
| 5. Prevent skin ulcerations. | 5. Proper care and protection of the skin, particularly the feet[14] or hands.<br>Proper nail care.[12]<br>Proper shoe selection and fit.[12]<br>Avoid use of support hose and restrictive clothing.<br>Avoid exposure to extremes of temperature, both hot and cold. |
| 6. Improve vasodilation in affected arteries. | 6. Vasodilation by iontophoresis.[2]<br>Vasodilation by reflex heating.[2]<br>NOTE: Although these physical measures have been advocated, their effectiveness is questionable. |
| 7. Prevent or minimize joint contractures and muscle atrophy, particularly if the patient is confined to bed. | 7. Repetitive, active ROM against low loads and/or gentle stretching exercises; proper positioning in bed to maintain joint and muscle extensibility. |
| 8. Promote healing of any skin ulcerations that develop. | 8. Wound management procedures for treating ischemic ulcers, including electrical stimulation and oxygen therapy.[27,55] |

cholesterol levels. These measures do not cure chronic arterial disorders but do minimize risk factors and promote wellness.

For patients with leg pain at rest due to advanced disease, reconstructive vascular surgery, such as a bypass graft, may be required. Patients with vasospastic disease may benefit from sympathetic blocks or sympathectomies to increase blood flow.[46] If a patient develops ulcerations or gangrene that cannot be treated medically or with conservative surgical procedures, amputation of the limb is necessary.[46,55]

### Role of Exercise

For patients with mild to moderate arterial disease, a graded exercise program should be initiated to improve exercise tolerance and functional capacity in activities of daily living. A regular program of mild- to moderate-level aerobic exercise, such as walking or bicycling, is known to have benefits for patients with chronic arterial insufficiency.[13,30,32,65,66,79]

Demonstrated benefits include an increase in the time before the onset of exercise pain during walking, improvement in the efficiency of oxygen utilization in exercising muscles (enabling patients to tolerate exercise over longer periods of time), and quantitative improvement of quality of life.[30,65,79] However, the characteristics of an optimal exercise program or whether exercise programs improve collateral circulation in the extremities is less clear.

### Focus on Evidence

Brandsma and co-investigators[13] conducted a systematic review of the literature to identify the indications, characteristics, and effectiveness of walking programs for patients with intermittent claudication. A review of 10 articles that met the inclusion criteria revealed no consensus with regard to indications for participation in a walking program for patients with intermitten claudication or optimal characteristics of such a program. However, the reviewers did confirm that all walking programs significantly improved walking distance in patients who participated in programs compared with those who did not.

In addition to increased walking distance, Gardner et al.[32] demonstrated by means of a randomized study of elderly individuals with chronic arterial insufficiency that after a 6-month walking program improvement in the distance walked before the onset of claudication was dependent on an increase in peripheral blood flow.

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Buerger or Buerger-Allen exercises, another approach to exercise developed a number of decades ago, were designed to promote collateral circulation through a series of positional changes of the affected limb (from an elevated to a dependent position) combined with active ankle pumping exercises.[82] Although used frequently in the past and occasionally today, there is little to no evidence to support the efficacy of these exercises for improving blood flow to an extremity.[27,54] Consequently, there is little reason to include them in a patient's exercise program.

## Special Considerations in a Graded Exercise Program for Patients with Chronic Arterial Insufficiency

### Rationale for Graded Exercise

The following factors related to the body's normal response to exercise are the basis for using a graded exercise program to improve the functional status of patients with chronic arterial insufficiency.[27,66,79]

- Blood flow temporarily decreases during active contraction of a muscle, but the blood flow rapidly increases immediately after the contraction.
- After cessation of exercise, there is a rapid decrease in blood flow during the first 3 to 4 minutes. This is followed by a slow decline to resting levels within 15 minutes.
- With repeated moderate-level exercise, blood flow in muscles can be increased beyond the resting values for blood flow.

### Exercise Guidelines

- The patient should be encouraged to walk or bicycle as far as possible to a predetermined maximum target heart rate but without causing intermittent claudication.
- The graded endurance exercise should be carried out 3 to 5 days per week.
- The patient should perform mild warm-up and stretching activities prior to initiating walking or bicycling. Warm-up activities could include active pumping exercises of the ankle and toes.
- Refer to Chapter 7 for additional guidelines for establishing an aerobic exercise program.

Precautions and contraindications for participation in a walking program for patients with chronic arterial insufficiency are noted in Box 24.4.[27,46,54,55]

**BOX 24.4 Precautions and Contraindications for a Walking Program for Patients with Chronic Arterial Insufficiency**

**Precautions**

- Avoid exercising outside during very cold weather.
- Wear shoes that fit properly, have sufficient padding, and do not cause skin irritation.
- Inspect the feet carefully for evidence of skin irritation after each exercise session.
- Discontinue a walking program if leg pain increases rather than decreases over time.

**Contraindications**

- Presence of skin irritation, an ulceration, a wound, or a fungal infection of the feet
- Leg pain at rest due to advanced vascular disease

# Disorders of the Venous System

Just as arterial disorders of the extremities can be acute or chronic, so can venous disorders.[34,40] Therapeutic exercise is one aspect of management of patients with an acute disease, such as thrombophlebitis, or a chronic disorder, such as varicose veins or chronic venous insufficiency.[27,33,46,54]

## Types of Venous Disorders

### Thrombophlebitis and Deep Vein Thrombosis

*Thrombophlebitis* is a disorder typically affecting the lower extremities and caused by thrombosis (the development/formation of a blood clot—i.e., a thrombus). It is characterized by acute inflammation with partial or complete occlusion of a superficial or deep vein.[27,33,38,42]

Lower extremity venous thrombosis can occur in the superficial vein system (greater or small saphenous veins) or the deep vein system (popliteal, femoral, or iliac veins) (Fig. 24.1).[33] A thrombus in one of the superficial veins in the calf usually is small and resolves without serious consequences.[33,67] In contrast, thrombus formation in a deep vein in the calf or more proximally in the thigh or pelvic region, known as a *deep vein thrombosis* (DVT), tends to be larger and can cause serious complications. When a clot breaks away from the wall of a vein and travels proximally, it is called an *embolus*. When an embolus affects pulmonary circulation, it is called a *pulmonary embolism*, which is a potentially life-threatening disorder.[33,67]

A lower extremity DVT is a common complication after musculoskeletal injury or surgery, prolonged immobilization, or bed rest and is attributed to venous stasis, injury to and inflammation of the walls of a vein, or a hypercoagulable state of the blood.[33,38,75] Risk factors for DVT are listed in Box 24.5.[33,38,67]

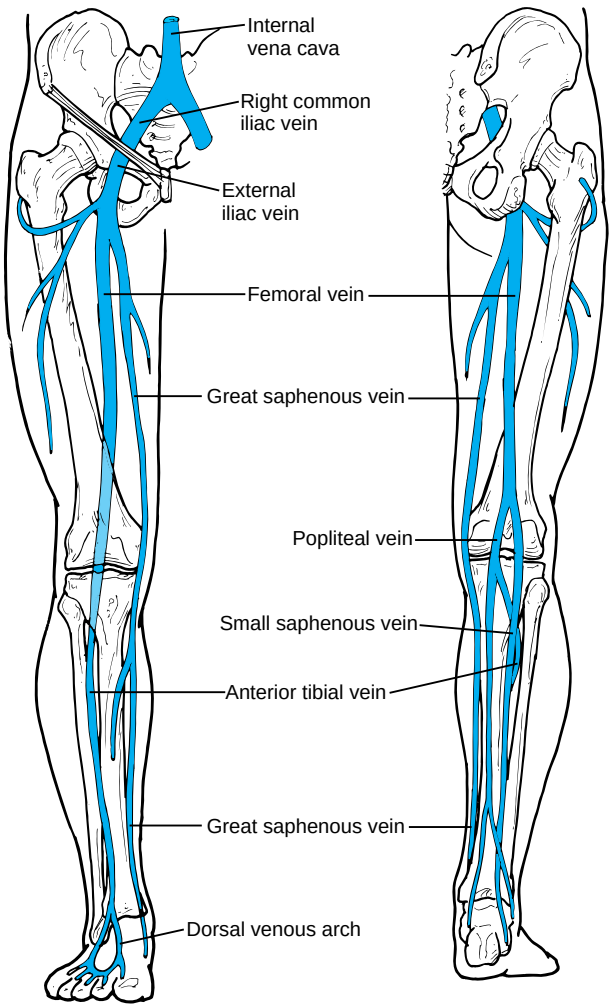


FIGURE 24.1 Veins of the lower extremity

### Chronic Venous Insufficiency

Chronic venous insufficiency is defined as inadequate venous return over a prolonged period of time. It may begin after a severe episode of DVT, may be associated with varicose veins, or may be the result of trauma to the lower extremities or blockage of the venous system by a neoplasm.[33,38,46] In all of these disorders damaged or incompetent valves in the veins prevent or compromise venous return, leading to venous hypertension and venous stasis in the lower extremities. Chronic pooling of blood in the veins causes inadequate oxygenation of cells and removal of waste products. This, in turn, leads to necrosis of tissues and the development of *venous stasis ulcers*.[33,38,55]

## Clinical Manifestations of Venous Disorders

### Deep Vein Thrombosis and Thrombophlebitis: Signs and Symptoms

During the early stages of a DVT, only 25% to 50% of cases can be identified by clinical manifestations, such as dull aching or severe pain, swelling, or changes in skin temperature and color, specifically heat and redness.[4,33,38,67]

Although edema in the vicinity of the clot may be present, it may be too deep to palpate. If the clot is in the

**BOX 24.5 Risk Factors for Deep Vein Thrombosis and Thrombophlebitis**

- Postoperative or postfracture immobilization
- Prolonged bed rest
- Trauma to venous vessels
- Limb paralysis
- Active malignancy (within past 6 months)
- History of deep vein thrombosis or pulmonary embolism
- Advanced age
- Obesity
- Sedentary lifestyle or extended episode of sitting during long-distance travel
- Congestive heart failure
- Use of oral contraceptives
- Pregnancy

calf (distal DVT), pain or tenderness of the calf may be felt with passive dorsiflexion of the affected foot (*Homans' sign*). However, the sensitivity of this test is poor and often reflects a false-negative or false-positive finding.[4,75] Only measurement by ultrasonography, venous duplex screening, or venography can confirm a DVT.[4,75]

### Pulmonary Embolism: Signs and Symptoms

As described previously, pulmonary embolism is a possible consequence of DVT. Risk factors for pulmonary embolism are similar to those already identified for DVT (see Box 24.5).

The signs and symptoms of pulmonary embolism vary considerably depending on the size of the embolus, the extent of lung involvement, and the presence of coexisting cardiopulmonary conditions.[84] The hallmark signs and symptoms are a sudden onset of shortness of breath (dyspnea), rapid and shallow breathing (tachypnea), and chest pain located at the lateral aspect of the chest that intensifies with deep breathing and coughing. Other signs and symptoms include swelling in the lower extremities, anxiety, fever, excessive sweating (diaphoresis), a cough, and blood in the sputum (hemoptysis).[84]

When a patient presents with signs or symptoms of possible pulmonary embolism, immediate medical referral is warranted for a definitive diagnosis.

### Chronic Venous Insufficiency: Signs and Symptoms

Dependent, peripheral edema occurring with long periods of standing or sitting is a common manifestation of chronic venous dysfunction. Edema decreases if the limb is elevated. Patients often report dull aching or tiredness in the affected extremity.[27,33,38,46,62,86] If the insufficiency is associated with varicose veins, venous distention (bulging) also is notable. When edema persists, the skin becomes less supple over time and takes on a brownish pigmentation.

## Examination and Evaluation of Venous Sufficiency

As with arterial disorders, a complete history and systems review help determine the presence of a venous disorder. Some specific tests to determine venous sufficiency are listed in Box 24.6 and are briefly described in this section.[27,34,42,53,62] These tests complement a comprehensive integumentary and neuromuscular examination that includes skin integrity, mobility, color, texture, temperature, vital signs including peripheral pulses, sensation, pain, functional mobility, ROM, strength, and cardiopulmonary endurance.

**BOX 24.6 Tests and Measures of Venous Sufficiency**

- Girth measurements of the upper or lower extremities
- Percussion test: compliance of the greater saphenous vein
- Homans' sign
- Response to compression of the limb with a blood pressure cuff
- Doppler ultrasonography
- Venous duplex screening/scanning
- Venography

### Girth Measurements

Circumferential measurements of the involved and uninvolved limbs are taken to determine the presence and extent of edema.[27,46,53] Measurements are taken at anatomical landmarks or at predetermined and consistent distances apart (e.g., 8 or 10 cm apart).

### Competence of the Greater Saphenous Vein (Percussion Test)

Evaluating the valves of the saphenous vein is a common test used if a patient has symptomatic varicose veins.

***Procedure.*** Ask the patient to stand until the veins in the legs appear to fill. While palpating a portion of the saphenous vein below the knee, sharply percuss a portion of the vein above the knee. If valves are not functioning adequately, the examiner feels a backflow of fluid distally under the palpating fingertips.[38,46,53]

### Tests for Deep Vein Thrombosis

The following tests determine the possible presence of a DVT in a lower extremity.

#### Homans' Sign

***Procedure.*** With the patient supine and the knee extended, passively dorsiflex the ankle and gently squeeze the calf muscles. If pain occurs in the calf, Homans' sign is positive, indicating the possible presence of a DVT.[4,46,53] However, this is not a definitive test. Homans' sign has been found to be positive in more than 50% of subjects who did not have a DVT. In addition, it has been shown to be positive in fewer than one-third of patients with a confirmed DVT in the calf.[4,75]

#### Application of a Blood Pressure Cuff Around the Calf

***Procedure.*** Inflate the cuff gradually until the patient experiences calf pain. A patient with acute thrombophlebitis usually cannot tolerate pressures above 40 mm Hg.[53]

### Additional Special Tests

Tests designed to confim the presence of a venous disorder are performed and analyzed by the patient's physician or a practitioner with specialized training. Tests include ultrasonographic imaging, Doppler measurement of blood flow, and venous duplex scanning (all of which are noninvasive) and venography (phlebography), an invasive procedure.[4,33,46,50,53] Venography involves injecting radiopaque dye and radiographic visualization of the venous system.

**BOX 24.7**
MANAGEMENT GUIDELINES—Deep Vein Thrombosis and Thrombophlebitis

**Impairments**
Dull ache or pain usually in the calf
Tenderness, warmth, and swelling with palpation

| Plan of Care | Interventions |
|---|---|
| 1. Relieve pain during the acute inflammatory period. | 1. Bed rest, pharmacological management (systemic anticoagulant therapy); elevation of the affected lower extremity, keeping the knee slightly flexed. |
| 2. As acute symptoms subside, regain functional mobility. | 2. Graded ambulation with legs wrapped in elastic or nonelastic bandages or when pressure-gradient support stockings are worn. |
| 3. Prevent recurrence of the acute disorder. | 3. Continuation of appropriate medical and pharmacological management. Use of strategies to prevent DVTs. |

**Contraindications:** Passive or active motion or application of moist heat; use of a sequential pneumatic compression pump.

## Prevention of Deep Vein Thrombosis and Thrombophlebitis

Every effort should be made to prevent the occurrence of a DVT and subsequent thrombophlebitis, particularly in patients at risk. The following interventions are implemented to reduce the risk of a DVT.[45,75,77]

- Prophylactic use of anticoagulant therapy (high-molecular-weight heparin) for the high-risk patient (e.g., the patient who has undergone lower extremity surgery or who is on bed rest)
- Initiation of ambulation as soon as possible after surgery, preferably no more than a day or two postoperatively
- Elevating the legs while lying supine and on a footstool or ottoman when sitting
- No prolonged periods of sitting, especially for the patient with a long-leg cast
- Active "pumping" exercises (active dorsiflexion, plantarflexion, and circumduction of the ankle) regularly throughout the day while lying supine in bed
- Use of compression stockings to support the walls of the veins and minimize venous pooling
- For patients on bed rest, use of a sequential pneumatic compression unit

## Management of Deep Vein Thrombosis and Thrombophlebitis

If the presence of DVT and resulting thrombophlebitis is confirmed, immediate medical intervention is essential to reduce the risk of pulmonary embolism. Initial management includes administering anticoagulant medication, placing the patient on complete bed rest, elevating the involved extremity, and using graduated compression stockings. The reported time frame for bed rest varies from 2 days to more than a week.[3] Box 24.7 summarizes the guidelines for management of acute DVT and thrombophlebitis.[27,46,54]

During the period of bed rest, exercises usually are contraindicated because movement of the involved extremity may cause pain and is thought to increase congestion in the venous channels when tissues are inflamed. However, the optimal timing of when it is prudent to discontinue bed rest and resume ambulation after initiating anticoagulant therapy is in question.

### Focus on Evidence

Aldrich and colleagues[3] conducted a systematic review of the literature to determine when a patient with DVT should be allowed to begin walking. The review revealed a limited number of studies (a total of five, three of which were randomized, controlled trials) that addressed this issue. Results of these studies suggest that early ambulation, begun within the first 24 hours after initiating anticoagulent therapy, does not increase the incidence of pulmonary embolism in patients without an existing pulmonary embolism and who have adequate cardiopulmonary reserve. However, if a patient has a known pulmonary embolism, an ambulation program must be initiated more cautiously. It is important to note that in the studies reviewed all patients who participated in an early ambulation program wore compression garments.

The results also revealed that early ambulation is associated with more rapid resolution of pain and swelling. The authors of the review were unable to identify studies that investigated the initiation and progression of other forms of exercise for patients with DVT.

## Management of Chronic Venous Insufficiency and Varicose Veins

Patient education is fundamental in the management of chronic venous insufficiency and varicose veins. A patient must be advised on how to prevent dependent edema, skin ulceration, and infections. The therapist may be involved

**BOX 24.8**
**MANAGEMENT GUIDELINES—Chronic Venous Insufficiency and Varicose Veins**

**Impairments**
Edema
Increased risk of skin ulcerations and infections
Aching of involved limb
Decreased functional mobility, strength, and endurance

| Plan of Care | Interventions |
|---|---|
| 1. Teach the patient how to prevent or minimize impairments. | 1. Patient education and self-management skills for skin care, self-massage for lymphedema, and a home exercise program. |
| 2. Prevent lymphedema; minimize venous stasis. | 2. Use of individually tailored pressure-gradient support stockings donned before getting out of bed in the morning and worn every day.<br>Support garment worn during exercise and ambulation.<br>Light active exercise, such as walking, on a regular basis.<br>Elevate the lower extremities after graded ambulation until the heart rate returns to normal.<br>Avoid prolonged periods of standing still and sitting with legs dependent.<br>Elevate involved limb(s) above the level of the heart (about 30° to 45°) when resting or sleeping (see Box 24.10 for additional methods to prevent lymphedema). |
| 3. Increase venous return and reduce lymphedema if already present. | 3. Use intermittent mechanical compression pump and sleeve with involved limb elevated for several hours a day.<br>Manual massage to drain edema. Stroke in a distal-to-proximal direction clearing the proximal nodes and areas of lymphedema first, then the middle, and finally the distal areas.<br>Relaxation and active ROM (pumping exercises) of the distal muscles while involved limb is elevated. |
| 4. Prevent skin abrasions, ulcerations, and wound infections. | 4. Proper skin care (see Box 24.10). |

in (1) measuring and fitting a patient for a pressure-gradient support garment; (2) teaching the patient how to put on the garment before getting out of bed; (3) setting up a program of regular exercise; and (4) teaching the patient proper skin care.

Box 24.8 summarizes the guidelines for management of chronic venous insufficiency and varicose veins.[27,46,54,56,62,86] Exercises and related interventions for chronic lymphedema described in the final section of this chapter are indicated for management of lymphedema arising from chronic venous insufficiency.

## Disorders of the Lymphatic System

One of the primary functions of the lymphatic system, which consists of lymph vessels and nodes, is to collect and clear excess tissue fluid from interstitial spaces and return it to the venous system (Fig. 24.2).[33,86] Edema is a natural consequence of trauma to and healing of soft tissues. If the lymphatic system is compromised and does not function efficiently, lymphedema develops and impedes wound healing.

*Lymphedema* is an excessive and persistent accumulation of extravascular and extracellular fluid and proteins in tissue spaces.[16,20,26,49,86] It occurs when lymph volume exceeds the capacity of the lymph transport system, and it is associated with a disturbance of the water and protein balance across the capillary membrane. An increased concentration of proteins draws larger amounts of water into interstitial spaces, leading to lymphedema.[26,39,86] Furthermore, many disorders of the cardiopulmonary system can cause the load on lymphatic vessels to exceed their transport capacity and subsequently cause lymphedema.[39,49]

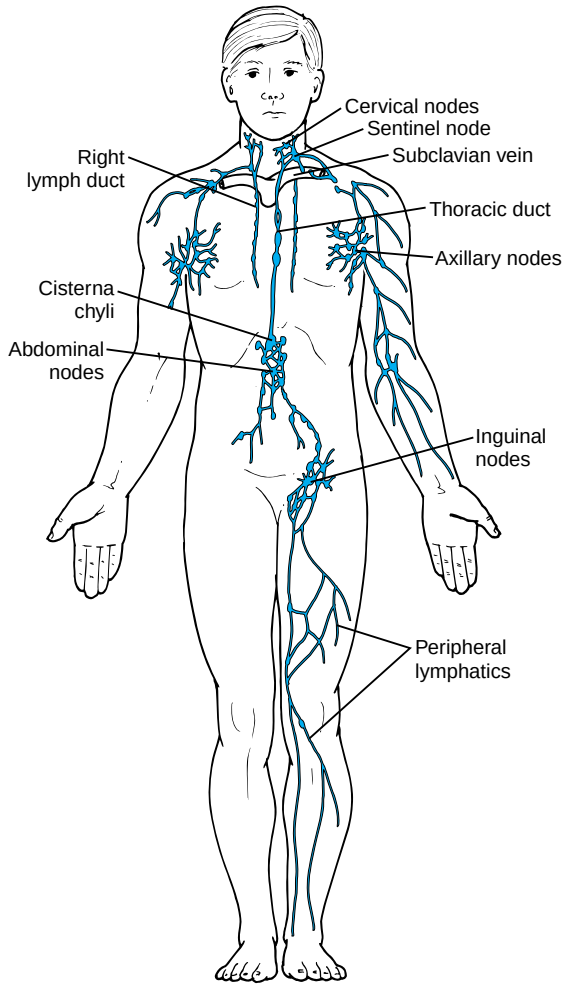


FIGURE 24.2 Major vessels of the lymphatic system.

## Conditions Leading to Insufficiency of the Lymphatic System

Disorders of the lymphatic transport system can cause primary or secondary lymphedema.[33] Remember, lymphedema is not a disease but, rather, a symptom of a malfunctioning lymphatic system. Most of the patients seen by health care practitioners for management of lymphedema have secondary lymphedema.[68] By far, the most common causes of secondary lymphedema are related to the comprehensive management of cancers of the breast, pelvis, and abdomen.[5,14,16,33,38,39,68,69]

### Congenital Malformation of the Lymphatic System

Primary lymphedema, although uncommon, is the result of insufficient development (dysplasia) and congenital malformation of the lymphatic system.[33,38]

### Infection and Inflammation

Inflammation of the lymph vessels (*lymphangitis*) or lymph nodes (*lymphadenitis*) and enlargement of lymph nodes (*lymphadenopathy*) can occur as the result of a systemic infection or local trauma. Any of these conditions can cause disruption of lymph circulation.[33,38,39,86]

### Obstruction or Fibrosis

Trauma, surgery, and neoplasms can block or impair the lymphatic circulation.[33,39,76] Radiation therapy associated with treatment of malignant tumors also can cause fibrosis of vessels.[5,15]

### Surgical Dissection of Lymph Nodes

Lymph nodes and vessels often are surgically removed (*lymphadenectomy*) as an aspect of treatment of a primary malignancy or metastatic disease. For example, axillary lymph node dissection is performed in most types of breast cancer surgeries to determine the extent and progression of breast cancer.[15,18,33,43] Likewise, pelvic or inguinal lymph node excision often is necessary for the treatment of pelvic or abdominal cancers.[5,68,69]

### Chronic Venous Insufficiency

Although not a primary disorder of the lymphatic system, chronic venous insufficiency and varicose veins are associated with venous stasis and accumulation of edema in the extremities.[33,38,46,86]

## Clinical Manifestations of Lymphatic Disorders

### Lymphedema

***Location.*** When lymphedema develops, it is most often apparent in the distal extremities, particularly over the dorsum of the foot or hand.[26,39] The term *dependent edema* describes the accumulation of fluids in the peripheral aspects of the limbs, particularly when the distal segments are lower than the heart. In contrast, lymphedema also can manifest more centrally, for example in the axilla, groin, or even the trunk.[26,33,38,86]

***Severity.*** The severity of lymphedema may be described quantitatively or qualitatively. Lymphedema is described by the severity of changes that occur in skin and subcutaneous tissues. The three categories—*pitting*, *brawny*, and *weeping* edema—are described in Box 24.9. Although all three types reflect a significant degree of lymphedema,

**BOX 24.9 Types of Lymphedema**

**Pitting edema:** Pressure on the edematous tissues with the fingertips causes an indentation of the skin that persists for several seconds after the pressure is removed. This reflects significant but short-duration edema with little or no fibrotic changes in skin or subcutaneous tissues.
**Brawny edema:** Pressure on the edematous areas feels hard with palpation. This reflects a more severe form of interstitial swelling with progressive, fibrotic changes in subcutaneous tissues.
**Weeping edema:** This represents the most severe and long-duration form of lymphedema. Fluids leak from cuts or sores; wound healing is significantly impaired. Lymphedema of this severity occurs almost exclusively in the lower extremities.

they are listed in order of severity, from least severe to most severe.[18,20,33,38,71]

Descriptors such as mild, moderate, and severe sometimes are based on how much larger the size of the edematous limb is compared with the noninvolved limb.[61] However, there are no standard definitions associated with size and severity.

### Increased Size of the Limb

As the volume of interstitial fluid in the limb increases, so does the size of the limb (weight and girth).[17,39,46,86] Increased volume, in turn, causes tautness of the skin and susceptibility to skin breakdown.[18,33]

### Sensory Disturbances

Paresthesia (tingling, itching, or numbness) or occasionally a mild aching pain may be felt particularly in the fingers or toes. In many instances the condition is painless, and the patient perceives only a sense of heaviness of the limb. Fine finger coordination also may be impaired as the result of the sensory disturbances.[18,39,61,71]

### Stiffness and Limited Range of Motion

Range of motion (ROM) decreases in the fingers and wrist or toes and ankle or even in the more proximal joints, leading to decreased functional mobility of the involved segments.[18,58]

### Decreased Resistance to Infection

Wound healing is delayed; and frequent infections (e.g., cellulitis) may occur.[39,46,86]

## Examination and Evaluation of Lymphatic Function

A patient's history, a systems review, and specific tests and measures provide information to determine impairments and functional limitations that can arise from lymphatic disorders and the presence of lymphedema. Key components in the examination process that are particularly relevant when lymphatic dysfunction is suspected or lymphedema is present are summarized in this section.[19,27,46,54,58,74,86] Other tests and measurements, such as vital signs, ROM, strength, posture, and sensory, functional, and cardiopulmonary testing, also are appropriate.

### History and Systems Review

Note any history of infection, trauma, surgery, or radiation therapy. The onset and duration of lymphedema, delayed wound healing, or previous treatment of lymphedema are pertinent pieces of information. Identify the occupation or daily activities of the patient and determine if long periods of standing or sitting are required.

### Examination of Skin Integrity

Visual inspection and palpation of the skin provide information about the integrity of the skin. The location of the edema should be noted. When the limb is in a dependent position, palpate the skin to determine the type and severity of lymphedema and changes in skin and subcutaneous tissues. Areas of pitting, brawny, or weeping edema should be noted.

NOTE: When palpating the skin over lymph nodes, note any tenderness of the nodes (cervical, supraclavicular, inguinal). Tenderness may or may not indicate ongoing infection or serious disease.[34] Evidence of warm, enlarged, tender, painless, or adherent nodes should be reported to the physician.

The presence of wounds or scars and the color and appearance of the skin, which often is shiny and red in an edematous limb, should be noted. Photographic documentation is convenient in the clinical or home setting and provides visual evidence of changes in skin integrity.[86] If a wound or scar is identified, its size should be noted, as should scar mobility or the presence of inflammation or infection in a wound.

### Girth Measurements

Circumferential measurements of the involved limb should be taken and compared with the noninvolved limb if the problem is unilateral.[17,54,61] Identify specific intervals or landmarks at which measurements are taken so measurements during subsequent examinations are reliable. Use of circumferential measurements at anatomical landmarks has been shown to be a valid and reliable method of calculating limb volume.[74]

### Volumetric Measurements

An alternative method of measuring limb size is to immerse the limb in a tank of water to a predetermined anatomical landmark and measure the volume of water displaced.[17,54,74] Although this method also has been shown to be valid and reliable, for routine clinical use it is more cumbersome and less practical than girth measurements.[74]

## Prevention of Lymphedema

If a patient is at risk of developing lymphedema secondary to infection, inflammation, obstruction, surgical removal of lymphatic structures, or chronic venous insufficiency, *prevention* of lymphedema should be the priority of patient management. In some situations, such as after removal of lymph nodes or vessels, preventive measures may be needed for a lifetime. Even when a patient takes every measure to prevent edema, it still may develop at some time, particularly after trauma to or surgical removal of lymph vessels. Box 24.10 summarizes precautions and measures to prevent or reduce the risk of lymphedema.[16,18,20,41,58,64,71,76,86]

## Management of Lymphedema

### Background and Rationale

Comprehensive management of lymphedema involves a combination of appropriate medical management and direct therapeutic intervention by a therapist combined with self-management by the patient. Treatment also includes appropriate pharmacological management for infection control and prevention or removal of excessive fluid and proteins.[16,33,38]

The overall goal of management when lymphedema has developed is to improve drainage of obstructed areas

**BOX 24.10 Precautions, Prevention, and Self-Management of Lymphedema**

### Prevention of Lymphedema

- Avoid static, dependent positioning of the lower extremities, such as prolonged sitting or standing. Avoid sitting with legs crossed.
- When traveling long distances by car, stop periodically and walk around or support an involved upper extremity on the car's window ledge or seat back.
- Elevate involved limb(s) and perform repetitive pumping exercises frequently during the day.
- Avoid *vigorous,* repetitive activities with the involved limb. Avoid carrying heavy loads, such as a suitcase, a heavy backpack, or shoulder bag. Avoid use of heavy weights when exercising.
- Wear compressive garments while exercising.
- Avoid wearing clothing that restricts circulation, such as sleeves or socks with tight elastic bands. Do not wear tight jewelry such as rings or watches.
- Monitor diet to maintain an ideal weight and minimize sodium intake.
- Avoid hot environments or use of local heat.
- If possible, avoid having blood pressure taken on an involved upper extremity or injections in either an involved upper or lower extremity.

### Skin Care

- Keep the skin clean and supple; use moisturizers but avoid perfumed lotions.
- Avoid infections; pay immediate attention to a skin abrasion or cut, an insect bite, a blister, or a burn.
- Protect hands and feet; wear socks or hose, properly fitting shoes, rubber gloves, oven mitts, etc.
- Avoid contact with harsh detergents and chemicals.
- Use caution when cutting nails. Women need to use an electric razor when shaving legs or underarm area.
- Avoid hot baths, whirlpools, and saunas that elevate the body's core temperature.

and theoretically to channel fluids into unobstructed, collateral vessels. The following must be accomplished to increase lymphatic drainage.

- The hydrostatic pressures on edematous tissues must be increased.[26] This is accomplished by *external compression of tissues* with manual lymphatic drainage, sequential pneumatic compression machines, or compressive garments.[16-19,48,58,76,86]

NOTE: It appears that compression facilitates the evacuation and reabsorption of fluids but does not increase the reabsorption of proteins in the edema fluid.[33]

- Lymphatic and venous return also is enhanced by *elevating* the involved limb. Lymphedema caused by infection or inflammation of the lymphatic system (e.g., lymphangitis or cellulitis) does not diminish as readily with elevation as does edema secondary to chronic venous insufficiency.[26,33,76]

### Comprehensive Regimens and Components

A comprehensive approach to the management of lymphedema is referred to in the literature by a variety of terms, including *complex lymphedema therapy, complete* or *complex decongestive physical therapy*, or *decongestive lymphatic therapy.*[10,11,21,22,25,44,51,52,70,72,85,86] Box 24.11 summarizes the components of these programs.

All of these regimens combine manual lymphatic drainage through light, superficial massage and compressive bandaging with active ROM, low-intensity resistance exercises, cardiopulmonary conditioning exercises, and good skin hygiene.

***Manual lymphatic drainage.*** Manual lymphatic drainage involves slow, very light repetitive stroking and circular massage movements done in a specific sequence with the involved extremity elevated whenever possible.[10,11,21,22,25,47,73,85,86] Proximal congestion in the trunk, groin, buttock, or axilla is cleared first to make room for fluid from the more distal areas. The direction of the massage is toward specific lymph nodes and usually involves *distal to proximal* stroking. Fluid in the involved extremity then is cleared, first in the proximal portion and then in the distal portion of the limb. Because manual lymphatic drainage is extremely labor- and time-intensive, methods of self-massage are taught to the patient as soon as possible in a treatment program.

***Exercise.*** Active ROM, stretching, and low-intensity resistance exercises are integrated with manual drainage techniques.[7,16,18,21,23,24,57,59,60,86] Exercises are performed while wearing a compressive garment or bandages and in a specific sequence, often with the edematous limb(s) elevated. A low-intensity cardiovascular/pulmonary endurance activity, such as bicycling, often follows ROM and strengthening exercises. Specific exercises and a suggested sequence for the upper and lower extremities, compiled from several sources, are described and illustrated in the last section of this chapter.

**BOX 24.11 Components of a Decongestive Lymphatic Therapy Program**

- Elevation
- Manual lymphatic drainage (massage)
  - Direct intervention by a therapist
  - Self-massage by the patient
- Compression
  - Nonelastic or low-stretch bandages or custom-fitted garments
  - Intermittent, sequential pneumatic compression pump
- Individualized exercise program
  - Active ROM (pumping exercises)
  - Flexibility exercises
  - Low-intensity resistance exercises
  - Cardiovascular conditioning
- Skin care and daily living precautions

***Elevation.*** The involved limb is elevated during use of a sequential compression pump, while sleeping or resting, or even during sedentary activities. The compressive bandages or garment are worn during periods of elevation.[11,16,18,58,76]

***Compressive bandages, garments, or pumps.*** No-stretch, nonelastic bandages or low-stretch elastic bandages or garments are recommended because they provide relatively low compressive forces on the edematous extremity at rest. In addition, they provide a higher working pressure with active muscular contractions because of their less yielding nature than high-stretch bandages.[16,18,21,25,76,86] High-stretch sports bandages, such as Ace wraps, are not recommended for treating lymphedema.[11,16,76] Daily use of a sequential, pneumatic compression pump also may be advisable during the early stages of treatment of substantial lymphedema.[16,19,25,58]

***Skin care and hygiene.*** Lymphedema predisposes the patient to skin breakdown, infection, and delayed wound healing. Meticulous attention to skin care and protection of the edematous limb are essential elements of self-management of lymphedema.[16,18,58,76]

#### Management Guidelines

Guidelines for the management of lymphatic disorders are essentially the same as those already described for the management of chronic venous insufficiency and associated lymphedema (see Box 24.8). As with chronic venous insufficiency, management of lymphatic disorders initially involves direct interventions by a therapist and an emphasis on patient education, followed by lifelong prevention and self-management by the patient.

#### Precautions and Self-Management of Lymphedema

Precautions that patients should take to prevent lymphedema and skin breakdown or infection are an important aspect of self-management (see Box 24.10).

#### Use of Community Resources

A valuable resource for patients and health care professions is the National Lymphedema Network (www.lymphnet.org). This nonprofit organization provides education and guidance about lymphedema. Another resource is the Lymphedema Internet Network (http://www.lymphedema.org).

## Breast Cancer-Related Lymphatic Dysfunction

### Background

Breast cancer-related dysfunction of the lymphatic system and subsequent lymphedema of the upper extremity is a somewhat common and potentially serious complication of the treatment for breast cancer. It is estimated that 15% to 20%[63] or as many as one in four patients[29] with invasive breast cancer develop upper extremity lymphedema during or sometime after the course of treatment.

Current treatment usually involves removing a portion or all of the breast accompanied by excision or irradiation of adjacent axillary lymph nodes, the principal site of regional metastases. Axillary dissection places a patient at risk not only for upper extremity lymphedema but also for loss of shoulder mobility and limited function of the arm and hand.[7,8,14,15,17,18,31,61,63,69] In addition, chemotherapy or hormonal therapy may also be employed.

Axillary dissection and removal of lymph nodes interrupt and slow the circulation of lymph, which in turn can lead to lymphedema.[7,15,18,29] Radiation therapy can cause fibrosis of tissues in the area of the axilla, which obstructs the lymphatic vessels and contributes to pooling of lymph in the arm and hand.[7,15,18,29] The extent of the axillary dissection and exposure to radiation is associated with the degree of risk for lymphedema to develop. In addition, shoulder motion can become impaired as the result of incisional pain, delayed wound healing, and skin ulcerations (associated with radiation therapy), and postoperative weakness of the muscles of the shoulder girdle.[18,58]

A comprehensive approach to postoperative management that emphasizes patient education and includes therapeutic exercise and other direct interventions to prevent or treat lymphedema and other impairments or functional limitations are key to successful outcomes.[5,8,16,18,58,64]

As with most cancers, the diagnosis of breast cancer and the ensuing treatments have an enormous emotional impact on patients and their families.[18,71] The advent of of breast cancer-related lymphedema not only has an impact on a breast cancer survivor's physical function but is known to have a significantly adverse effect on health-related quality of life, making prevention of lymphedema and, if it develops, aggressive treatment high priorities for management.[69]

### Surgical Procedures

Surgical treatment of breast cancer falls into two broad categories—mastectomy and breast-conserving surgeries—both of which are coupled routinely with partial or complete axillary node dissection. Differences in surgical procedures are related to the extent of removal of breast tissue and surrounding or underlying soft tissues.[1,10,40] A course of radiation therapy routinely follows surgery to decrease the risk of regional recurrence of the disease. Chemotherapy also may be initiated postoperatively to prevent the systemic spread of the disease.

#### Mastectomy

Mastectomy involves removing the entire breast. In addition, a mastectomy may involve removing the fascia over the chest muscle. With late-stage, invasive disease, a radical mastectomy in which the pectoralis muscles also are excised may be required, leading to significant muscle weakness and impaired shoulder function.

#### Breast-Conserving Surgery

Options for resecting the tumor and preserving a portion of the breast include *lumpectomy*, which involves excision of

the mass and a margin of healthy surrounding breast tissue, or *segmental mastectomy* (also known as *quadrectomy),* which is excision of the affected quadrant of the breast. These procedures are being used increasingly, rather than mastectomy, in combination with adjuvant therapy for patients with stage I or II tumors.[1,40]

There are now multiple randomized clinical trials that show that the 10- to 20-year survival rate for patients with stage I or II disease who underwent breast-conserving surgery combined with radiation therapy is equivalent to that achieved by patients who underwent mastectomy alone or mastectomy with adjuvant therapy.[1]

Patients who undergo breast-conserving procedures without removal of lymph nodes are still at risk for developing postoperative lymphedema and impaired shoulder mobility because of potential complications from radiation therapy and biopsy of at least one lymph node.[18,58]

### Dissection of Axillary Lymph Nodes (Lymphadenectomy)

As mentioned, at this time axillary lymph node dissection is a standard part of mastectomy and breast-conserving surgery, although the extent of node removal is controversial.[1,40] A minimum of a level I axillary node dissection and removal of the sentinel node in the axilla at the lateral borders of the breast is required for biopsy to assess regional lymph node involvement and for staging the disease. More extensive dissection for metastatic disease removes the nodes under the pectoralis minor muscle or around the clavicle

## Impairments and Complications Related to Breast Cancer Treatment

The following impairments and complications may occur in association with treatment of breast cancer. Many of these problems are interrelated and must be considered jointly when a comprehensive postoperative rehabilitation program is developed for the patient.*

### Postoperative Pain

***Incisional pain.*** A transverse incision across the chest wall is made to remove the breast tissue and underlying fascia on the chest musculature. The incision extends into the axilla for lymph node dissection. Postoperatively, the sutured skin over the breast area may feel tight along the incision. Movement of the arm pulls on the incision and is uncomfortable for the patient. Healing of the incision may be delayed as the result of radiation therapy. Delayed wound healing, in turn, prolongs pain in the area of the incision.

***Posterior cervical and shoulder girdle pain.*** Pain and muscle spasm may occur in the neck and shoulder region as a result of muscle guarding. The levator scapulae, teres major and minor, and infraspinatus often are tender to palpation and can restrict active shoulder motion. Decreased use of the involved upper extremity after surgery due to pain sets the stage for the patient to develop a chronic frozen shoulder and increases the likelihood of lymphedema in the hand and arm.

### Postoperative Vascular and Pulmonary Complications

Decreased activity and extended time in bed increase venous stasis and the risk of DVT. Risk of pulmonary complications, such as pneumonia, also is higher because of the patient's reduced activity level. Incisional pain may make the patient reluctant to cough or breathe deeply, both of which are necessary postoperatively to keep the airways clear of fluid accumulation.

### Lymphedema

As noted previously, patients who undergo any level of lymph node dissection or whose treatment regimen includes radiation therapy remain at risk throughout life for developing ipsilateral upper extremity lymphedema.[7,18,58,86] Lymphedema can occur almost immediately after lymph node dissection, during the course of radiation therapy, or many months or even years after treatment has been completed. It is typically evident in the hand and arm but occasionally develops in the upper chest or back area.[15,18,58,61,86] In turn, lymphedema leads to impaired upper extremity function, poor cosmesis, and emotional distress.[18,31,61,71]

### Chest Wall Adhesions

Restrictive scarring of underlying tissues on the chest wall can develop as the result of surgery, radiation fibrosis, or wound infection. Chest wall adhesions can lead to increased risk of postoperative pulmonary complications, restricted mobility of the shoulder, postural asymmetry and dysfunction, and discomfort in the neck, shoulder girdle, and upper back.

### Decreased Shoulder Mobility

It is well documented that patients may experience temporary and sometimes long-term loss of shoulder mobility after surgery or radiation therapy for treatment of breast cancer.[7,37,43,58,64,80,81,83] Factors contributing to impaired shoulder mobility after surgery are listed in Box 24.12.

### Weakness of the Involved Upper Extremity

***Shoulder weakness.*** If the long thoracic nerve is traumatized during axillary dissection and removal of lymph nodes, this results in weakness of the serratus anterior and compromised stability of the scapula, limiting active flexion and abduction of the arm. Faulty shoulder mechanics and use of substitute motions with the upper trapezius and levator scapulae during overhead reaching can cause subacromial impingement and shoulder pain. Shoulder impingement, in turn, can be a precursor to a frozen shoulder. If the pectoralis muscles were disturbed, which occurs with a radical mastectomy for advanced disease, weakness is evident in horizontal adduction.

***Decreased grip strength.*** Grip strength is often diminished as the result of lymphedema and secondary stiffness of the fingers.

*See refs. 6, 8, 14, 15, 18, 31, 36, 37, 43, 58, 61, 81, 83, 86.

**BOX 24.12 Factors Contributing to Impaired Shoulder Mobility After Breast Cancer Surgery**

- Incisional pain immediately after surgery or associated with delayed wound healing
- Muscle guarding and tenderness of the shoulder and posterior cervical musculature
- Need for protected shoulder ROM until the surgical drain is removed
- Fibrosis of soft tissues in the axillary region due to adjuvant radiation therapy
- Adherence of scar tissue to the chest wall, causing adhesions
- Temporary or permanent weakness of the muscles of the shoulder girdle
- Rounded shoulders and kyphotic or scoliotic trunk posture associated with age or incisional pain
- A feeling of heaviness of the upper extremity due to lymphedema
- Decreased use of the hand and arm for functional activities

### Postural Malalignment

The patient may sit or stand with rounded shoulders and kyphosis because of pain, skin tightness, or psychological reasons. An increase in thoracic kyphosis associated with aging is commonly seen in the older patient.[36] This contributes to faulty shoulder mechanics and eventually restricts active use of the involved upper extremity. Asymmetry of the trunk and abnormal scapular alignment may occur as the result of a subtle lateral weight shift, particularly in a large-breasted woman.

### Fatigue and Decreased Endurance

Patients undergoing radiation therapy or chemotherapy often experience debilitating fatigue.[1,33] Anemia may develop as a result of chemotherapy. Nutritional intake and subsequent energy stores may be diminished, particularly if a patient is experiencing nausea for several days after a cycle of chemotherapy. Fatigue also is associated with depression. As a result, exercise tolerance and endurance during functional activities are markedly reduced.

### Psychological Considerations

A patient undergoing treatment for breast cancer experiences a wide range of emotional and social issues.[71] The needs and concerns of both the patient and the family must be considered. The patient and family members must cope with the potentially life-threatening nature of the disease and a difficult treatment regimen. It is common for a patient to feel anxiety, agitation, anger, depression, a sense of loss, and significant mood swings during treatment and recovery from breast cancer.

In addition to the obvious physical disfigurement and altered body image associated with mastectomy, medications such as immunosuppressants and corticosteroids can affect the emotional state of a patient. Psychological manifestations affect physical well-being and can contribute to general fatigue, the patient's perception of functional disability, and motivation during treatment.

## Guidelines for Management After Breast Cancer Surgery

Guidelines for postoperative management for the patient who has undergone a mastectomy or breast-conserving surgery and who may currently be receiving adjuvant therapy are outlined in Box 24.13. The guidelines identify therapeutic interventions for common impairments during the early postoperative period and those that could develop at a later time.

NOTE: The guidelines outlined in Box 24.13 also can be modified to prevent or manage problems that can develop in the trunk and lower extremities after surgery for abdominal or pelvic cancers and accompanying inguinal lymph node dissection.

### Special Considerations

***Patient education.*** The length of stay for patients after surgery for breast cancer is short. Therefore, direct intervention by a therapist starts on the first postoperative day with an emphasis on patient education for *prevention* of postoperative complications and impairments, including pulmonary complications, thromboemboli, lymphedema, and loss of shoulder mobility. Recommendations for preventing lymphedema or for self-management if it develops are reviewed with the patient (see Box 24.10).

***Exercise.*** The postoperative exercise program focuses on three main areas: improving shoulder function, regaining an overall level of fitness, and preventing or managing lymphedema. Early, but protected, assisted or active ROM of the shoulder is the key to restoring shoulder mobility. Postoperative risks that contribute to restricted shoulder mobility were summarized previously (see Box 24.12).[1,18,40,58,60] These risks are highest during the early postoperative period until drains have been removed and the incision has healed.

NOTE: Radiation therapy to the axillary and breast areas can delay wound healing beyond the typical 3- to 4-week period.[1,40] Even after initial healing of the incision, the scar has a tendency to contract and can become adherent to underlying tissues, which, in turn, can restrict shoulder motion.

Although strengthening exercises and aerobic conditioning are important for upper extremity function and total body fitness, *moderation* in an exercise program is imperative. Exercises must be progressed gradually, excessive fatigue must be avoided, and energy conservation must be emphasized, especially if the patient is undergoing chemotherapy or radiation therapy. Exercise precautions for the patient undergoing treatment are noted in Box 24.14.[7,18,60,64]

**BOX 24.13**
## MANAGEMENT GUIDELINES—After Surgery for Breast Cancer

### Potential Postoperative Impairments

Pulmonary and circulatory complications
Lymphedema
Restricted mobility of the upper extremity
Postural malalignment
Weakness and decreased functional use of the upper extremity
Fatigue and decreased endurance for functional activities
Emotional and social adjustments

| Plan of Care | Interventions |
|---|---|
| 1. Prepare the patient for postoperative self-management. | 1. Interdisciplinary patient education involving all aspects of potential impairments and functional limitations.<br>Self-management activities and preparation for participation in a home program on the first postoperative day. |
| 2. Prevent postoperative pulmonary complications and thromboemboli. | 2. Pre- or postoperative instruction in deep breathing, emphasizing maximal inspirations and effective coughing (see Chapter 25).<br>Active ankle exercises (calf pumping exercises). |
| 3. Prevent or minimize postoperative lymphedema. | 3. Elevation of the involved upper extremity on pillows (about 30°) while the patient is in bed or sitting in a chair. Wrapping the involved upper extremity with bandages or wearing an elastic pressure gradient sleeve.<br>Pumping exercises of the arm on the side of the surgery.<br>Early ROM exercises.<br>PRECAUTION: Avoid static, dependent positioning of the arm. |
| 4. Decrease lymphedema if or when it develops. | 4. Manual lymphatic drainage massage.<br>Daily regimen of exercises to reduce lymphedema.<br>Use of custom-fit elastic compression garment when lymphedema is stabilized.<br>Adherence to precautions for skin care (see Box 24.10). |
| 5. Prevent postural deformities. | 5. Posture awareness training; encourage the patient to assume an erect posture when sitting or standing to minimize a rounded shoulder posture.<br>Posture exercises with an emphasis on scapular retraction exercises. |
| 6. Prevent muscle tension and guarding in cervical musculature. | 6. Active ROM of the cervical spine to promote relaxation.<br>Shoulder shrugging and shoulder circle exercises.<br>Gentle massage to cervical musculature. |
| 7. Prevent restricted mobility of the upper extremity. | 7. Active-assistive and active ROM exercises of the shoulder, elbow, and hand initiated as soon as possible but cautiously usually on the first postoperative day.<br>NOTE: Exercise may be initiated even when the drainage tubes and sutures are still in place.<br>After the incision has healed, self-stretching to the shoulder. |
| 8. Regain strength and functional use of the involved extremity. | 8. Upper extremity ergometry initially against minimal and, later, moderate resistance.<br>Use of the involved extremity for light functional activities. |
| 9. Improve exercise tolerance and sense of well-being; reduce fatigue. | 9. Graded, low-intensity aerobic exercise such as walking or cycling. |
| 10. Provide information about resources for patient and family support and ongoing patient education. | 10. Resources: American Cancer Society for family support and ongoing patient education (www.cancer.org); National Breast Cancer Coalition; National Lymphedema Network. |

**Precautions:** Shoulder exercise should be performed within *protected* ROM, usually no more than 90° of elevation of the arm until after removal of drains. Observe the incision and sutures carefully during exercises. Avoid any undue tension on the incision or blanching of the scar during shoulder exercises. Avoid exercises with the involved arm in a dependent position. Progress graded exercise program very slowly, particularly if the patient is receiving adjuvant therapy.

**BOX 24.14 Exercise Precautions and Treatment of Breast Cancer**

- Exercise only at a moderate level and never to the point that the affected arm aches during or after exercise, even if there is no evidence of lymphedema.
- Monitor upper extremity girth measurements closely.
- Adjust the *timing* of exercise during cycles of radiation therapy or chemotherapy. With some chemotherapy medications, a patient can develop cardiac arrhythmia and therefore should not perform aerobic exercises, such as stationary cycling, for 24 to 48 hours after a chemotherapy session.
- Return to more physically demanding work and recreational activities gradually after completion of chemotherapy or radiation therapy.

Although early intervention for the prevention of lymphedema and upper extremity mobility impairments is often advocated by therapists and suggested in descriptive articles in the literature, patients often are not referred for postoperative rehabilitation until after impairments and functional limitations have developed. This may be due to concerns raised in the literature[29] that early postoperative ROM could disturb drains or delay wound healing or that exercises, if performed too vigorously, could initiate or exacerbate lymphedema. In addition, few studies have rigorously investigated the efficacy of specific interventions or rehabilitation protocols.[58,80] However, a recent review of the literature of exercise and cancer-related lymphedema revealed that exercise neither worsened preexisting lymphedema nor was associated with a significant increase in the occurrence of lymphedema.[7]

From the information available in the literature, the following recommendations for exercise are made.*

- Integrate several interventions including exercise, massage, and use of compression devices into a patient's comprehensive plan of care.
- Implement shoulder ROM exercises early in a postoperative program to prevent mobility impairments.
- Include moderate-intensity aerobic conditioning exercises to improve fitness and quality of life.
- Progress all forms of exercise gradually and avoid any form of high-intensity training.

***Community resources*** Reach to Recovery is a one-to-one patient education program sponsored by the American Cancer Society (www.cancer.org). Representatives of this program, most of whom are breast cancer survivors, provide emotional support to the patient and family as well as current information on breast prostheses and reconstructive surgery. The National Lymphedema Network (www.lymphnet.org) is another valuable source of information for patients at risk for or who have developed lymphedema.

*See refs. 6, 14, 15, 17, 18, 31, 37, 44, 52, 57, 59, 60, 72, 80, 81, 85, 86.

# EXERCISES FOR THE MANAGEMENT OF LYMPHEDEMA

## Background and Rationale

As noted previously in this chapter, exercise is just one aspect of a decongestive lymphatic therapy program. The rationale for including exercise in the comprehensive treatment of patients with upper or lower extremity lymphedema is to move and drain lymph fluid to reduce the edema and to improve the functional use of the involved limb or limbs. Principles on which exercises for lymphatic drainage are based are summarized in Box 24.15.[7,59,86]

The exercises employed in lymph drainage regimens cover a wide spectrum of therapeutic exercise interventions, specifically deep breathing, relaxation, flexibility, strengthening, cardiovascular conditioning exercises, and a sequence of lymphatic drainage exercises as well. Exercise regimens have been described in an extensive number of publications.* No particular combination or sequence of exercises has been shown to be superior to another. Although a critical review of the literature a decade ago[62] indicated that the effectiveness of exercise regimens for lymph drainage was based primarily on clinical observations and opinions of experienced practitioners or case reports, there is now an emerging body of evidence documenting the efficacy of specific components of these programs.[7,44,57,58,72]

## Components of Exercise Regimens for Management of Lymphedema

### Deep Breathing and Relaxation Exercises

- Deep breathing is interwoven throughout exercise regimens for the management of lymphedema. It has been

**BOX 24.15 Exercises for Lymphatic Drainage: Principles and Rationale**

- Contraction of muscles pumps fluids by direct compression of the collecting lymphatic vessels.
- Exercise reduces soft tissue and joint hypomobility that can contribute to static positioning and lead to lymphostasis.
- Exercise strengthens and prevents atrophy of muscles of the limbs, which improves the efficiency of the lymphatic pump.
- Exercise increases heart rate and arterial pulsations, which in turn contribute to lymph flow.
- Exercise should be sequenced to clear the central lymphatic reservoirs before the peripheral areas.
- Wearing compression bandages during exercises enhances lymph flow and protein reabsorption more efficiently than exercising without bandages.

*See refs. 10, 11, 18, 21-24, 41, 44, 48, 51, 52, 59, 60, 64, 69, 72, 85, 86.

suggested that the use of abdominal-diaphragmatic breathing assists in the movement of lymphatic fluid as the diaphragm descends during a deep inspiration and the abdominals contract during a controlled, maximum expiration.[18] Changes in intra-abdominal and intrathoracic pressures create a gentle, continual pumping action that moves fluids in the central lymphatic vessels, which run superiorly in the chest cavity and drain into the venous system in the neck (see Fig. 24.2).

- Progressive, total body relaxation exercises[28] (described in Chapter 4 of this text) are performed at the beginning of each exercise session to decrease muscle tension, which may be contributing to restricted mobility and lymph congestion.[18,21,24,86] Deep breathing is an integral component of the sequence of relaxation exercises.

#### Flexibility Exercises

Gentle, self-stretching exercises are used to minimize soft tissue and joint hypomobility, particularly in proximal areas of the body that may contribute to static postures and lymph congestion.

#### Strengthening and Muscular Endurance Exercises

Both isometric and dynamic exercises using self-resistance, elastic resistance, and weights or weight machines are appropriate if done against light resistance (initially, 1 to 2 lb) and by progressing resistance and repetitions gradually. Regardless of whether lymphedema has developed, it is important to monitor the circumferential size and the skin texture of the involved limb closely to determine whether an appropriate intensity of exercise has been established. Emphasis is placed on improving endurance and strength of central and peripheral muscle groups that enhance an erect posture and minimize fatigue in muscles that contribute to the efficiency of the lymphatic pump mechanism.

#### Cardiovascular Conditioning Exercises

Activities such as upper extremity ergometry, swimming, cycling, and walking increase circulation and stimulate lymphatic flow.[18] Thirty minutes of aerobic endurance exercises complement lymph drainage exercises. Conditioning exercises are done at low intensity (at 40% to 50% of the target heart rate) when lymphedema is present and at higher intensities (up to an 80% level) when the lymphedema has been reduced and exercise is otherwise safe.[18,59]

#### Lymphatic Drainage Exercises

Lymphatic drainage exercises, often referred to as *pumping exercises*, move fluids through lymphatic channels. Active, repetitive ROM exercises are performed throughout each session. *The exercises follow a specific sequence to move lymph away from congested areas.*[18,21,23,24,86] It is similar to the sequence of massage applied during manual lymph drainage.[47,73] In general, the exercises first focus on proximal areas of the body to clear central collecting vessels and then involve distal muscle groups to begin to move peripheral edema in a centripedal direction to the central lymph vessels. The affected upper or lower extremity or extremities are held in an elevated position during many of the exercises. Static, dependent postures are avoided. Self-massage also is interspersed throughout the exercise sequence to further enhance drainage. These exercises also maintain mobility of the involved limbs.

## Guidelines for Lymphatic Drainage Exercises

The patient should follow these guidelines when performing a sequence of lymphatic drainage exercises. These guidelines apply to management of upper or lower extremity lymphedema and reflect the combined opinions of several authors and experts in the field.[18,21-23,59,86]

#### Preparation for Lymphatic Drainage Exercises

- Set aside approximately 20 to 30 minutes for each exercise session.
- Perform exercises twice daily every day.
- Have needed equipment at hand, such as a foam roll, wedge, or exercise wand.

#### During Lymphatic Drainage Exercises

- Wear compression bandages or a customized compression garment.
- Precede lymphatic drainage exercises with total body relaxation activities.
- Follow a specified order of exercises.
- Perform active, repetitive movements slowly, about 1 to 2 seconds per repetition.
- Elevate the involved limb above the heart during distal pumping exercises.
- Combine deep breathing exercises with active movements of the head, neck, trunk, and limbs.
- Initially, perform a low number of repetitions. Increase repetitions gradually to avoid excessive fatigue.
- Do not exercise to the point where the edematous limb aches.
- Incorporate self-massage into the exercise sequence to further enhance lymph drainage.
- Maintain good posture during exercises.
- When strengthening exercises are added to the lymph drainage sequence, use light resistance and avoid excessive muscle fatigue.

#### After Lymphatic Drainage Exercises

- If possible, rest with the involved extremity elevated for 30 minutes.
- Set aside time several times per week for low-intensity aerobic exercise activities, such as walking or bicycling for 30 minutes.
- Carefully check for signs of redness or increased swelling in the edematous limb, either of which could indicate that the level of exercise was excessive.

## Selected Exercises for Lymphatic Drainage: Upper and Lower Extremity Sequences

The selection and sequences of exercises described in this section and summarized in Box 24.16 are designed to assist

**BOX 24.16 Sequence of Selected Exercises for Management of Upper or Lower Extremity Lymphedema**

### Exercises Common to Upper and Lower Extremity Regimens

NOTE: Start an upper or lower extremity regimen with these exercises

- Deep breathing and total body relaxation exercises
- Posterior pelvic tilts and partial curl-ups
- Cervical ROM
- Bilateral scapular movements

### Upper Extremity Exercises

- Active circumduction with the involved arm elevated while lying supine
- Bilateral active movements of the arms while lying supine or on a foam roll
- Bilateral hand press while lying supine or sitting
- Shoulder stretches (with wand, doorway, or towel) while standing
- Active elbow, forearm, wrist, and finger exercises of the involved arm
- Bilateral horizontal abduction and adduction of the shoulders
- Overhead wall press while standing
- Finger exercises
- Partial curl-ups
- Rest with involved upper extremity elevated

### Lower Extremity Exercises

- Alternate knee to chest exercises
- Bilateral knees to chest
- Gluteal setting and posterior pelvic tilts
- Single knee to chest with the involved lower extremity
- External rotation of the hips while lying supine with both legs elevated and resting on a wedge or wall
- Active knee flexion of the involved lower extremity while lying supine
- Active plantarflexion and dorsiflexion and circumduction of the ankles while lying supine with lower extremities elevated
- Active hip and knee flexion with legs externally rotated and elevated against a wall
- Active cycling and scissoring movements with legs elevated
- Bilateral knee to chest exercises, followed by partial curl-ups
- Rest with lower extremities elevated

in the drainage of upper or lower extremity lymphedema. Many of the individual exercises suggested in lymphedema protocols, such as ROM of the cervical spine and some of the shoulder girdle or upper extremity exercises, are not exclusively used for lymph drainage. They also are used to improve mobility and strength. Several of the exercises highlighted in this section already have been described in previous chapters in this text. Only those exercises or variations of exercises that are somewhat unique or not previously addressed are described or illustrated in this section.

### Sequence of Exercises

- Total body relaxation exercises are implemented prior to lymphatic drainage exercises.
- Exercises for lymphatic drainage should follow a particular sequence to assist lymph flow. The central and proximal lymphatic vessels, such as the abdominal, inguinal, and cervical nodes (see Fig. 24.2), are cleared first with trunk, pelvic, hip, and cervical exercises. Then, for the most part, exercises proceed distally from shoulders to fingers or from hips to toes. If lymph nodes have been surgically removed (e.g., with a unilateral axillary node dissection for breast cancer or a bilateral inguinal node dissection for cancers of the abdominal or pelvic organs), lymph must be channeled to the remaining nodes in the body.

NOTE: Because no single sequence of exercises has been shown to be more effective than another, the upper and lower extremity sequences of exercises outlined in this section do not reflect the exercises included in any one specific protocol. Rather, the exercise sequences are based on the recommendations of several authors.[18,21-23,44,57-59,72,86] Sequences of exercises for upper or lower extremity lymphedema are summarized in the remaining portion of this chapter. Therapists are encouraged to modify or add other exercises to the sequences in this chapter as they see fit to meet the individual needs of their patients.

### Exercises Common to Upper and Lower Extremity Sequences

These initial exercises should be included in programs for unilateral or bilateral upper or lower extremity lymphedema. They are designed to help the patient relax and then to clear the central channels and nodes.

- ***Total body relaxation***
  - Have the patient assume a comfortable supine position and begin deep breathing. Then, isometrically contract and relax the muscles of the lower trunk (abdominals and erector spinae) followed by the hips, lower legs, feet, and toes.
  - Then contract and relax the muscles of the upper back, shoulders, upper arms, forearms, wrist, and fingers.
  - Finally, contract and relax the muscles of the neck and face.
  - Relax the whole body for at least a minute.
  - Perform diaphragmatic breathing throughout the entire sequence. Avoid breath-holding and the Valsalva maneuver.

- ***Posterior pelvic tilts and partial curl-ups***
  - Perform these exercises with hips and knees flexed, in the supine position.
- ***Unilateral knee-to-chest movements.*** These exercises are designed to target the inguinal nodes. This is important even for upper extremity lymphedema.
  - In the supine position flex one hip and knee, and grasp the lower leg. Pull the knee to the chest. Gently press or bounce the thigh against the abdomen and chest about 15 times.
  - Repeat the procedure with the opposite lower extremity.

NOTE: If lymphedema is present in only one lower extremity, initiate the knee-to-chest exercises with the *uninvolved* lower extremity.

- ***Cervical ROM.*** Perform each motion for a count of 5 for five repetitions.
  - Rotation
  - Lateral flexion
- ***Scapular exercises.*** Perform exercise for a count of 5 for five repetitions.
  - Active elevation and depression (shoulder shrugs)
  - Active shoulder rolls
  - Active scapular retraction and protraction. With arms at sides and elbows flexed, bilaterally retract the scapulae, pointing elbows posteriorly and medially. Then protract the scapulae.

NOTE: Be sure to shrug the shoulders as high as possible and then *actively* pull down the shoulders (depress the scapulae) as far as possible

### Exercises Specifically for Upper Extremity Lymphedema Clearance

The following sequence of exercises is performed after the general, total body exercises just described. The exercises, which are performed in a proximal to distal sequence, are done specifically for upper extremity lymph clearance.

NOTE: Periodically during the exercise sequence have the patient perform self-massage to the axillary node area of the *uninvolved* side proceeding from the axilla to the chest.

- ***Active circumduction of the arm (Fig. 24.3).*** While lying supine, flex the involved arm to 90° (reach toward the ceiling) and perform active circular movements of the arm about 6 to 12 inches in diameter. Do this clockwise and counterclockwise, five repetitions in each direction.

PRECAUTION: Avoid pendular motions or circumduction of the edematous upper extremity with the arm in a dependent position.

- ***Exercises on a foam roll (Fig. 24.4).*** While lying supine on a firm foam roll (approximately 6 inches in diameter), perform horizontal abduction and adduction as well as flexion and extension of the shoulder. These movements target congested axillary nodes and are done unilaterally. For home exercises, if special equipment such as an Ethyfoam® roller is not available, have the patient perform these exercises on a foam pool "noodle." Although the diameter is smaller, a towel or folded sheet can be wrapped around the foam "noodle" to increase the diameter of the roll.

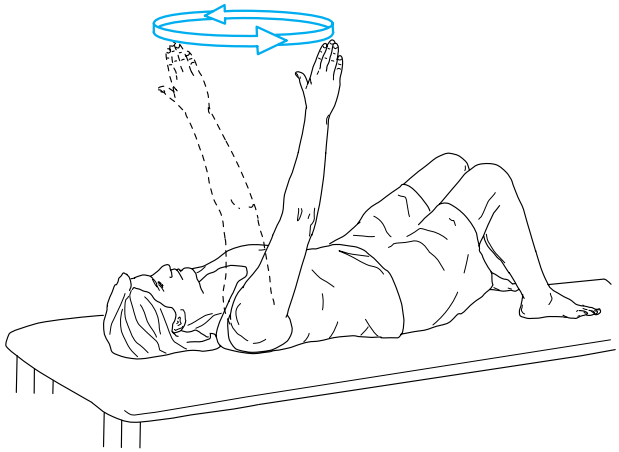

FIGURE 24.3 Active circumduction of the edematous extremity.

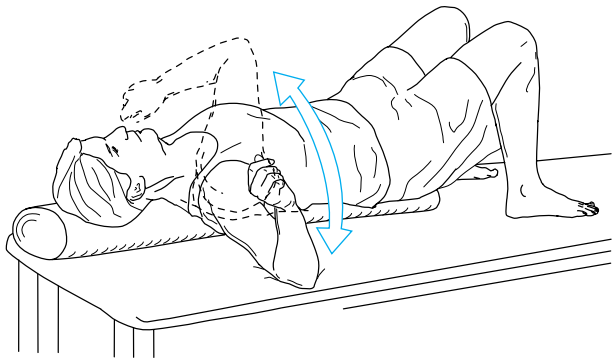

FIGURE 24.4 Active shoulder exercises on a firm, foam roll.

- ***Bilateral hand press.*** With arms elevated to shoulder level or higher and the elbows flexed, place the palms of the hands together in front of the chest or head. Press the palms together (for an isometric contraction of the pectoralis major muscles) while breathing in for a count of 5. Relax and then repeat up to five times.
- ***Wand exercise, doorway or corner stretch, and towel stretch.*** Incorporate several exercises to increase shoulder mobility and to decrease congestion and assist lymph flow in the upper extremity. Hold the position of stretch for several seconds with each repetition. These exercises have been described and are illustrated in Chapter 17.
- ***Unilateral arm exercises with the arm elevated.*** The following exercises are done with the patient seated and the arm supported at shoulder level on a tabletop or countertop or with the patient supine and the arm supported on a wedge or elevated overhead.
  - Shoulder rotation with the elbow extended. Turn the palm up, then down, by rotating the shoulder, not simply pronating and supinating the forearm.
  - Elbow flexion and extension.
  - Circumduction of the wrist.
  - Hand opening and closing.

- ***Bilateral, horizontal abduction and adduction.*** While standing or sitting, place both hands behind the head. Horizontally adduct and abduct the shoulders by bringing the elbows together and then pointing them laterally.
- ***Overhead wall press.*** Face a wall; place one or both palms on the wall with the hands above shoulder level. Gently press the palms into the wall for several seconds without moving the body. Relax and repeat approximately five times.
- ***Wrist and finger exercises.*** If swelling is present in the wrist and hand, repetitive active finger movements are indicated with the arm elevated.
  - After performing the overhead wall press as just described, keep the heel of the hand on the wall and alternatively move all of the fingers away from and back to the wall (Fig. 24.5).
  - In the same position as just described, alternately press individual fingers into the wall, as if playing a piano, while keeping the heel of the hand in contact with the wall.
  - Place the palms of both hands together with the hands overhead or at least above shoulder level. One finger at a time, press matching fingers together and then pull them away from each other.
- ***Partial curl-ups.*** To complete the exercise sequence, perform additional curl-ups (about five repetitions) with hands sliding on the thighs.
- ***Rest.*** Rest in a supine position with the involved arm elevated on pillows for about 30 minutes after completing the exercise sequence.

### Exercises Specifically for Lower Extremity Lymphedema Clearance

NOTE: After completing the general lower body, neck, and shoulder exercises previously described, have the patient perform self-massage first to the axillary lymph nodes on the *involved* side of the body. Then massage the lower abdominal area superiorly to the waist and then laterally and superiorly to the axillary area of the involved side. This sequence is repeated periodically throughout the lower extremity exercise sequence.

- ***Unilateral knee-to-chest movements.*** In the supine position, repeat this exercise for another 15 repetitions. If lymphedema is present in only one lower extremity, perform repeated knee to chest movements with the *uninvolved leg first* and then the involved leg.
- ***Bilateral knees to chest.*** In the supine position, flex both hips and knees, grasp both thighs, and gently pull them to the abdomen and chest. Repeat 10 to 15 times.
- ***Gluteal setting and posterior pelvic tilts.*** Repeat five times, holding each contraction for several seconds and then slowly releasing.
- ***External rotation of the hips (Fig. 24.6).*** Lie in the supine position with the legs elevated and resting against a wall or on a wedge. Externally rotate the hips, pressing the buttocks together, and holding the outwardly rotated position. Repeat several times.
- ***Knee flexion to clear the popliteal area.*** While lying in the supine position and keeping the uninvolved lower extremity extended, flex the involved hip and knee enough to clear the foot from the mat table. Actively flex the knee as far as possible by quickly moving the heel to the buttocks. Repeat approximately 15 times.
- ***Active ankle movements.*** With both legs elevated and propped against a wall, or just the involved leg propped against a door frame and the uninvolved leg resting on the floor, actively plantarflex the ankle and curl the toes; then dorsiflex the ankle and extend the toes as far as possible for multiple repetitions. Finally, actively circumduct the foot clockwise and counterclockwise for several repetitions.
- ***Wall slides in external rotation (Fig. 24.7).*** With the feet propped up against the wall, legs externally rotated, and

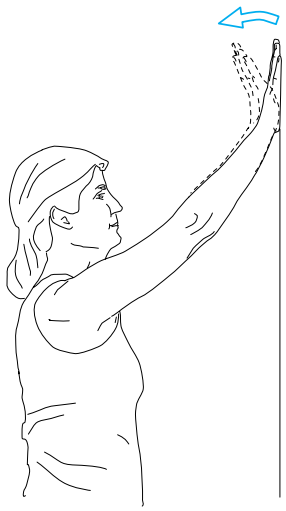

FIGURE 24.5 Overhead wall press.

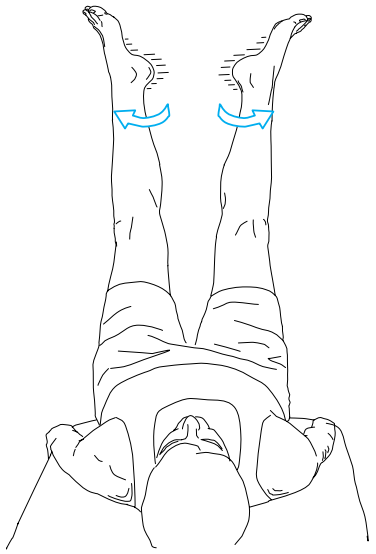

FIGURE 24.6 Repeated outward rotation of the hips with legs elevated.

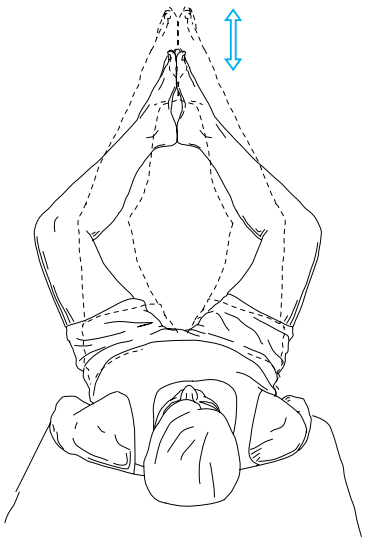

FIGURE 24.7 Wall slides with hips externally rotated.

heels touching, slide both feet down the wall as far as possible and then back up the wall for several repetitions.

- ***Leg movements in the air (Fig. 24.8).*** With both hips flexed and the back flat on the floor and both feet pointed to the ceiling, alternately move the legs, simulating cycling, walking, and scissoring motions.
- ***Hip adduction across the midline (Fig. 24.9).*** Lie in the supine position with the uninvolved leg extended. Flex the hip and knee of the involved leg. Grasp the lateral aspect of the knee with the contralateral hand; pull the involved knee repeatedly across the midline in a rocking motion.

NOTE: If lymphedema is bilateral, repeat this exercise with the other lower extremity.

- ***Bilateral knee to chest.*** Repeat bilateral gentle, bouncing movements of the legs previously described.
- ***Partial curl-ups.*** To complete the exercise sequence, perform additional partial curl-ups, about five repetitions.
- ***Rest.*** With feet elevated and legs propped up against the wall, rest in this position for several minutes after completing exercises. Then rest the legs partially elevated on a wedge, and remain in this position for another 30 minutes.

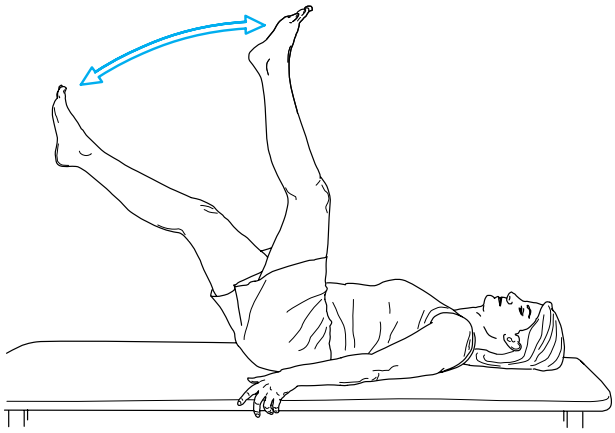

FIGURE 24.8 Repeated walking movements.

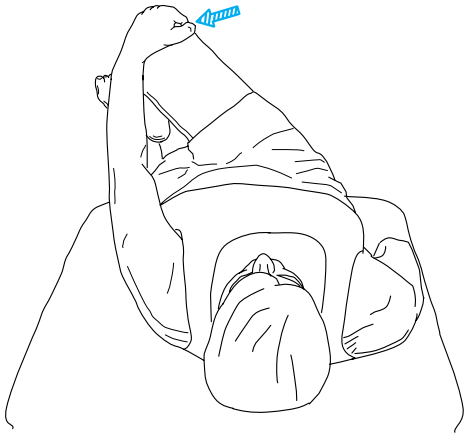

FIGURE 24.9 Hip adduction across the midline to clear inguinal nodes.

## INDEPENDENT LEARNING ACTIVITIES

### Critical Thinking and Discussion

1. Differentiate between the signs and symptoms associated with chronic arterial insufficiency and chronic venous insufficiency.
2. You have been asked to participate in a patient education program at your community's cancer society for patients who have undergone surgery for breast cancer. Your responsibility in this program is to help these breast cancer survivors prevent physical impairments and functional limitations associated with their surgery and any related adjuvant therapies. Outline the components of such a program, and explain the rationale for the activities you have chosen to include.
3. What part does a program of exercise and physical activity play in the overall prevention or management of deep vein thrombophlebitis? What are the signs and symptoms of DVT that a patient at risk for this problem must learn to recognize? If you suspect that a patient you are seeing after some type of orthopedic surgery of the lower extremity has developed a DVT, what questions should you ask the patient? What should you do before contacting the patient's physician?

4. A patient presents with leg pain that occurs intermittently during the day but not at night. Describe how you would evaluate the patient's signs and symptoms and determine whether the cause of the pain is vascular or neurological.

## Laboratory Practice

Perform the sequence of exercises and suggested repetitions for the exercise plan you have designed for case 2 (Ms. L).

## Case Studies

### CASE 1

Mr. A, a 65-year-old man with a 5-year history of type II diabetes and peripheral vascular disease, has been referred to you in your home health practice to establish a program to help him improve his overall level of physical activity. He enjoys golf but recently has had difficulty completing a round because of calf pain that occurs when he walks for even short distances along the course. His pain goes away when he stands or sits.

What additional information do you need to secure during the examination and evaluation process? What tests and measurements would be of particular importance? From your evaluation, design a plan of care that includes a program of exercise to help Mr. A improve his level of physical activity and prevent vascular-related complications.

### CASE 2

Ms. L underwent surgery for metastatic pelvic cancer and lymphadenectomy (lymph node dissection) 3 months ago. She also received a series of radiation therapy treatments as part of her comprehensive oncologic management. About 2 weeks ago, she began to notice bilateral swelling in her legs, most notably in her feet and ankles.

She has been referred by her oncologist to the outpatient facility where you work to "evaluate and treat" her for her lymphedema. Describe the examination procedures you would use in your evaluation and then develop a plan of care, including a program of exercise, to help her manage and reduce her lymphedema and prevent potential complications related to the lymphedema.

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