SECTION V

Environmental Factors and Pathophysiology

CHAPTER 25

Immobility and Associated Problems

CHAPTER OUTLINE

LEARNING OBJECTIVES

After studying this chapter, the student is expected to:

1. Describe the possible effect of immobility on skeletal muscle, bone, and joints.
2. Discuss the development of decubitus ulcers.
3. Explain the changes in blood pressure and potential thrombus formation.
4. List the potential problems related to respiratory function.
5. Discuss the common effects of immobility on appetite, bowel function, and urinary function.
6. Discuss the potential effects of immobility on the nervous system and psychological implications.
7. Describe the potential effect of immobility on a child's growth.

KEY TERMS

atelectasis
basal metabolic rate
contracture
decubitus ulcers
diplegia
extensor
flaccidity
flexor
hemiplegia
orthostatic hypotension
osteoblastic
osteoclastic
paraplegia
pneumonia
quadriplegia
stasis
supine

Factors Involving Immobility

Immobility, or lack of movement, may involve only one part of the body such as a fractured arm in a cast. A part of the body may be affected, as occurs with paralysis: one side of the body (**hemiplegia**), the lower half of the body (**paraplegia**), or the trunk and all four limbs (**quadriplegia**). **Diplegia** refers to symmetric paralysis in any area of the body. In a coma or during an acute illness the entire body may be immobilized. The effects of such inactivity depend on the extent of the immobilization and its duration. Physiotherapy or passive exercise imposed on the involved area of the body can minimize the effects of lack of voluntary movement. Respiratory therapy is significant in preventing infections such as pneumonia.

When the body is **supine** (lying on the back), the loss of the force of gravity affects many of its natural functions, primarily in the intestines and urinary tract. Other noticeable effects result from the lack of stress normally exerted on bone by skeletal muscle and the decreased circulation of blood. Bed rest also alters respiratory function, metabolism, and renal function.

Musculoskeletal System Effects

Inactive muscle loses strength, endurance, and mass very quickly. Perhaps you have seen an arm or a leg shriveled up with *atrophied* muscle (often called disuse atrophy) after it has been confined to a cast for several weeks. Loss of muscular strength due to immobility progresses at a rate of about 12% each week. After 3 to 5 weeks of immobility due to bed rest almost one-half of the muscular strength is lost. Correct positioning and reduction of abnormal stress on immobilized muscles and joints are important because these structures may stretch or shorten, resulting in abnormal fixation of a joint, altering biomechanics. For example, an ankle may develop contractures when a tight, heavy blanket or improper positioning puts excessive and inappropriate pressure on the foot (Fig. 25-1). Generally **flexor** muscles are stronger than the opposing **extensor** muscles (which atrophy more than the flexor muscles), and this imbalance may allow an inactive joint to take an abnormal position if flexibility is not maintained by range-of-motion exercises. With inactivity, tendons and ligaments shorten and lose elasticity. Prolonged immobility causes fibrous tissue to replace muscle cells, leading to muscle wasting and weakening, decreased flexibility, further possibly irreversible deformity (**contracture**), and loss of function.

The lack of muscular activity impairs venous return, which causes pooling of blood in dependent areas of the body, development of dependent edema, and a decrease in cardiac output, which may cause dizziness or fainting when changing position.

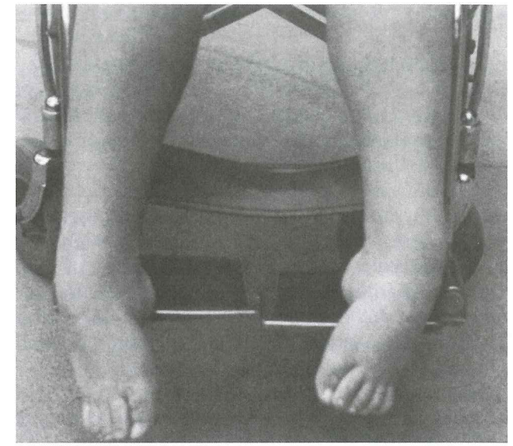

FIGURE 25-1 Contracture of the feet in a patient with muscular dystrophy. *(From Jahss MH:* Disorders of the Foot and Ankle, *vol. 1, ed 2, Philadelphia, 1991, Saunders.)*

Bone deteriorates with inactivity. Bone is a "living" tissue in which new bone is constantly forming (**osteoblastic** activity) and other bone is being resorbed (**osteoclastic** activity). Bone demineralization occurs because the lack of weight bearing and muscle action reduces osteoblastic activity or bone formation; however, osteoclastic activity continues. This process leads to loss of bone mass and *osteoporosis* with the potential for spontaneous fractures if undue stress is placed on the bones (see Chapters 24 and 9).

The breakdown of muscle and bone tissue initially results in elevated serum levels of nitrogen wastes such as creatinine and in elevated serum calcium. Hypercalcemia may cause renal calculi or kidney stones if fluid intake is inadequate and the urine becomes too concentrated (see Chapter 18). Also a high serum calcium level can further impede muscle activity because it decreases muscle tone and leads to **flaccidity** or loss of muscle tone. Passive range-of-motion exercises and weight bearing if tolerated on a regular basis are helpful in preventing these complications.

Tendons and ligaments that connect the muscles to bone and maintain joint structure also require movement to maintain their structure and functionality. After 4 to 6 days of immobility these forms of connective tissue begin to shorten and the density of the tissue increases limiting flexibility and range of motion.

THINK ABOUT 25-1

a. Explain effects of immobility on posture and joints.
b. Explain how immobility can lead to osteoporosis.

Cutaneous Effects

The skin breaks down easily when its circulation is impaired and cell regeneration is reduced. Blood supply is often reduced in places where the skin is stretched over bony projections and there is little fatty or muscular tissue to cushion the weight of the body. Areas that are particularly vulnerable to poor blood perfusion include the ischial tuberosities, sacrum, the greater trochanter of the hip, the heels, and the elbows. Pressure at these points causes ischemia and necrosis of tissue (Fig. 25-2), leading to **decubitus ulcers** (pressure sores or bedsores). Other factors that promote skin breakdown and development of decubiti include:

- Poor general circulation or anemia
- Edema
- Inadequate subcutaneous tissue in the elderly or debilitated person
- Loss of sensation
- Prolonged static positioning
- Mechanical irritation or friction by clothing, braces, or other equipment
- Excessive moisture from perspiration or urine
- Poor personal hygiene
- Inadequate nutrition or hydration
- Trauma to the skin due to friction against clothing or sheets if a patient is moved without due care or slides down in bed, or if skeletal muscle spasms occur; adhesive tape may irritate the skin directly or indirectly when it is removed

Pressure ulcers are difficult to heal unless the predisposing conditions can be removed.

The affected area first appears red, and then superficial skin breakdown is apparent. Ulceration follows, and the area may become a purplish-red color if the damage is deep. Eventually necrosis destroys deeper tissue, and a large open area develops with full-thickness damage. Local infection is common.

The risk of skin breakdown can be reduced if sensitive areas are protected by sheepskin pads or flotation devices and the patient's position is changed frequently to avoid prolonged pressure in certain areas, thereby maintaining adequate circulation.

FIGURE 25-2 Decubitus ulcer. *(From Callen J, Greer K, Hood A, et al:* Color Atlas of Dermatology, *Philadelphia, 1993, Saunders.)*

THINK ABOUT 25-2

a. Explain why an elderly person confined to a wheelchair might develop decubitus ulcers.
b. Suggest several specific ways of reducing the risk of skin breakdown and ulceration.

Cardiovascular System Effects

Initially when a person is fully immobilized, the horizontal body position leads to more blood returning to the heart from the legs. Blood pools in the trunk, especially in the lungs. Initially this increased venous return leads to an increased intracardial pressure, increasing the heart rate and stroke volume.

With *prolonged* immobility and bed rest, venous return and cardiac output are reduced, and the patient is subject to **orthostatic hypotension** with short periods of dizziness or fainting, pallor and sweating, and rapid pulse whenever the body position is quickly changed. Normally skeletal muscle contractions as part of regular activity assist in returning the venous blood to the heart. Also when the body position changes from supine to upright, reflex vasoconstriction occurs in the skin and viscera to promote venous return. Adequate venous return ensures sufficient cardiac output to supply the brain and prevent a drop in blood pressure and fainting. When a patient becomes mobile after a prolonged period of bed rest, it may take several weeks for the reflex controls to return to normal, ensuring adequate circulation.

Other problems occur when the blood pools in dependent areas. The increased volume of blood in these areas leads to increased capillary pressure and edema (see Chapter 2). A persistent increase in interstitial fluid (edema) leads to reduced arterial flow and capillary exchange of nutrients in that dependent area, thus predisposing the person to tissue necrosis, ulcers, and infection in the area. Even if a small area such as an arm is immobilized, the limb should be elevated to reduce edema.

The **stasis** or pooling of blood associated with immobility promotes thrombus formation in the veins, particularly in the legs. In addition to sluggish blood flow and decreased venous return, blood clots may be encouraged by compression or damage to blood vessels resulting from pressure related to the body position in bed or a wheelchair. Action of skeletal muscles, such as the contractions of the calf muscles, compresses the major veins in the legs aiding in the venous flow back to the heart. Blood clotting is also encouraged in patients with dehydration or cancer by the increased coagulability of the blood associated with these conditions. The combination of three factors; venous stasis, hypercoagulability and blood vessel damage are known as Virchow's triad and when present, they dramatically increase the chances of a deep vein thrombosis. Thrombi are a threat because a thrombus may break away with movement or massage, resulting in a *pulmonary embolus*, which has serious consequences for respiratory and cardiovascular function (see Chapter 13). Depending on the primary problem, antiembolic stockings, exercises, or anticoagulant therapy may be helpful prophylactic measures.

Respiratory System Effects

Initially when a person is immobilized, there is less demand for oxygen because metabolism is decreased, unless some factor such as infection is increasing the resting rate of metabolism or **basal metabolic rate** (BMR); therefore the respiratory system can easily meet the body's requirements. Usually respirations become slow and shallow.

When the person is supine in bed, deep breathing and coughing become more difficult because chest expansion is restricted by body weight and the upward pressure of the abdominal contents against the diaphragm. Gas exchange is decreased as thoracic capacity is reduced and ventilation is diminished. Any muscle weakness will impair the effectiveness of respiratory efforts. Many drugs, including sedatives (to promote sleep and reduce anxiety) and analgesics (to control pain), depress neuromuscular activity and the respiratory control center, leading to slowed, shallow respirations.

When a person is immobilized, secretions build up in the airways and are difficult to remove because the cough mechanism is less effective. Ciliary action may be reduced if nutrition is impaired or the patient is a smoker. Other factors leading to increased secretions in the lungs include more viscous mucus due to dehydration and inflammation due to instrumentation, related to surgery or testing procedures. Increased fluids in the lungs further impair lung expansion. Stasis of secretions predisposes the patient to serious respiratory complications. The increased mucous secretions frequently lead to infection (hypostatic **pneumonia**) or obstruction of the airway and collapse of the lung (**atelectasis**). Pneumonia and atelectasis may also result from aspiration of food or water intake, which occurs more easily when the patient is immobilized or in a supine position. Normally in the upright position, gravity assists the rapid movement of food down the esophagus.

Respiratory therapy, including breathing exercises, may be helpful and are frequently part of the preoperative preparation. Personal respirometers provide an incentive for patients to improve their ventilation capacity before and after surgery.

THINK ABOUT 25-3

Explain why pneumonia is a common occurrence in immobilized persons.

Digestive System Effects

The major problem associated with immobility and the gastrointestinal tract is constipation. Elimination is affected by the slower passage of feces through the intestine due to muscle inactivity and body position, which results in a harder stool. In people who are ill, the intake of food, fiber, and fluid is often reduced, leading to reduced peristalsis in the intestine and more water absorption from the fecal mass. Weakened muscles make defecation more difficult, as does the awkwardness of using a bedpan in a supine position. The elderly patient is particularly vulnerable to bowel complications. In addition to using appropriate laxatives, an increase in fiber and fluid intake will reduce the problem of constipation in the patient with decreased activity.

When a person is inactive, appetite is often reduced, leading to decreased dietary intake. This may result in a negative nitrogen balance (protein deficit), especially when muscle tissue is breaking down. The protein imbalance contributes to a low hemoglobin level and delays in healing. Unfortunately, the decreased food intake usually aggravates fatigue and depression, which further decrease appetite and ultimately may cause malnutrition and further delays in healing and recovery. New liquid products to deliver adequate calories and nutrients are somewhat easier for the immobilized person to consume. If normal nutrition cannot be maintained orally, it may be necessary to use t1otal parenteral nutrition (TPN), in which the required nutrient solution is administered directly into a vein or via a nasogastric tube.

In some cases immobility can lead to obesity. When a person is inactive, caloric intake can quickly exceed the energy expended. Also there may be an increase in snacking as a result of stress and discomfort.

Urinary System Effects

Stasis of urine in the kidneys or bladder frequently causes infection or renal calculi (stones) to develop in the urinary tract (see Chapter 18). A supine position leads to residual urine in the calyces of the kidney in the dependent area because normal drainage by gravity into the ureter is impeded. It is also difficult to empty the bladder completely into a bedpan when one is supine or the muscles are weakened. Renal calculi are more likely to develop in people with hypercalcemia caused by prolonged immobility or with reduced fluid intake. Bladder infection (cystitis) is common in immobilized people if calculi form or catheters are used to drain the urine.

Another potential effect on the urinary system involves an increase of diuresis, leading to dehydration. A blood shift into the thorax can potentially stimulate release of atrial natriuretic peptide (ANP) from the heart which acts as a powerful diuretic. This blood shift can also stretch the aortic arch and receptors in the carotid sinus, which reduces antidiuretic hormone (ADH) release. This reduction in ADH will reduce the reabsorption of water by the kidneys, which further increases the diuretic effect of the ANP and increasing overall urine output, which can lead to dehydration.

Neurological/Psychological Effects

Prolonged pressure on the skin and underlying tissue as well as resultant tissue damage can activate pain sensations as sense receptors such as exteroceptors, mechanoceptors, or nociceptors are stimulated. Over time the continued pressure can cause serious local tissue damage that can destroy the nerves, resulting in a new sensation of tingling in the affected area and eventually a total loss of feeling in the area. Damage to the nerves and innervation of the muscles can also result in spasms.

In addition to the psychological effects of pain, the person's lack of control over his or her environment can have negative psychological effects. These effects include depression, anxiety, confusion, and forgetfulness. The overall increased levels of stress involved in immobility has been linked to the release of stress hormones such as corticosteroids, which can result in widespread physiologic changes affecting an individual's overall health.

THINK ABOUT 25-4

Explain how immobility may affect the urinary system to produce a systemic as well as local effect.

Effects of Immobility on Children

When children are immobilized for an extended period of time, normal growth is often delayed because the physical movement to stimulate bone and muscle development is lost. Catch-up growth may be possible when mobility returns. Depending on the underlying condition, deformities involving the hips, spine, hands, and feet may develop. Other developmental delays are common when sensory and experiential stimulations are decreased.

CASE STUDY A

Trauma and Immobility

L.D. is a 27-year-old man who has no chronic health problems. He prides himself on keeping fit and enjoys "living on the edge." Last weekend he was thrown from his motorcycle when it spun out on a wet patch of pavement. In the emergency department, he was diagnosed with fractures of the left tibia and ribs. He reported being in pain and having difficulty breathing. He was discharged with a full leg cast and medication for pain to be taken every 4 hours as needed. He was told not to bear any weight on his affected leg and was shown how to walk with crutches.

1. How will L.D.'s broken ribs affect his respiration and what potential problem may occur if L.D. does not follow instructions to breathe deeply and cough?
2. How does the pain medication affect his ability to deep breathe and move?
3. How will L.D.'s lifestyle, health habits, and age affect healing of the damaged tissues?
4. L.D.'s pain medication makes him nauseated. Why is it important for him to maintain a diet high in calcium, protein, and vitamins C and D?
5. L.D.'s skin itches under the cast and he finds this very irritating. On one very hot day, he resorts to inserting his mother's knitting needle under the cast to scratch the skin. Why are skin breakdown and infection greater risks in the cast limb?
6. After 4 weeks L.D.'s cast seems quite loose and it is replaced with a new walking cast. L.D. is distressed to see that the leg is thinner than it was. What is the cause of the change in the size and shape of L.D.'s fractured leg?
7. What problems is L.D. likely to experience when the cast is finally removed from his leg?

CHAPTER SUMMARY

Immobility may involve one part of the body (e.g., a limb) or a major portion of the body, and it may be temporary or permanent.

- Effects on muscle and bone develop within a short period. Skeletal muscle atrophies with loss of strength and mass, osteoporosis occurs, and contractures may arise.
- Skin breakdown or decubitus ulcers develop easily, particularly where pressure causes ischemia after the person remains in one position for a long time.
- Orthostatic hypotension and thromboembolism are two problems associated with cardiovascular function.
- Deep breathing and cough effectiveness may be restricted by immobility, predisposing to stasis of secretions in the lungs, followed by pneumonia.
- Reduced peristalsis associated with immobility frequently leads to constipation.
- Immobility may predispose to urinary stasis, renal calculi, infection and dehydration
- Immobility can cause the stimulation of sensory receptors in the skin and effected tissue leading to pain.
- Growth in children is frequently delayed during periods of immobility.

STUDY QUESTIONS

1. Explain how immobility affects the circulation.
2. Give several reasons why healing may be delayed during a period of immobility.
3. Explain how frequent changes of position would affect:
   a. the amount of interstitial fluid in an area
   b. respiratory function
   c. the skin

ADDITIONAL RESOURCES

Hockenberry MJ: *Wong's Essentials of Pediatric Nursing*, ed 7, St. Louis, 2005, Mosby.

Lewis SM, Heitkemper MM, Dirksen SR, O'Brien PG, Bucher L: *Medical-Surgical Nursing: Assessment and Management of Clinical Problems*, ed 7, St. Louis, 2007, Mosby.

Potter PA, Perry AG: *Fundamentals of Nursing*, ed 7, St. Louis, 2009, Mosby.

Web Sites

http://www.geronurseonline.org *Gerontological Nursing (American Nurses Association)*

http://depts.washington.edu/rehab/sci *Northwest Regional Spinal Cord Injury System (University of Washington)*

http://nsweb.nursingspectrum.com/ce/ce127.htm *Nursing Spectrum*

http://www.nursingtimes.net/ *Nursing Times*

http://www. ncbi.nlm.nih.gov/ *National Center for Biotechnology Information*