Chapter 8

THE INJURY PROCESS

I. The Physics of Sports Injury.

A. The body has many different types of tissues. **Connective tissue** is the most common type in the body. Connective tissues include ligaments, retinaculum, joint capsules, bone, cartilage, fascia, and tendons.

1. In some sports, nearly 50% of injuries are acute and involve either muscle or tendon tissue.

B. Muscle and fascia are thought to be injured when excessive tension is applied during contraction, particularly **eccentric contractions**, which are described as "the simultaneous processes of muscle contraction and stretch of the muscle tendon unit by an extrinsic force."

C. Although tendons are strong, strains commonly occur at the distal musculotendinous junction. Musculotendinous strains are the most common soft tissue sports injury.

II. The Mechanical Forces of Injury.

Three types of force can affect connective tissues. These forces are tensile, compressive, and shear. Although tendons resist tensile forces, they are less effective against shear and compressive forces. Bone resists compression but is less effective against tension and shear forces. Ligament, like tendon, resists tensile forces, and is more vulnerable to shear and compression.

A. Regardless of tissue type, each has a limit to how much force it can withstand (**critical force**).

1. The critical force varies for each tissue type and may vary within the same tissue. Factors such as age, temperature, skeletal maturity, gender, and body weight can affect mechanical properties of ligaments, for example.

III. The Physiology of Sports Injury

A. The Inflammatory Process. Whenever tissues are damaged, the body reacts quickly with a predictable sequence of physiologic actions to repair the damage.

1. The body's initial response to **trauma** is inflammation, commonly referred to as swelling. The inflammatory process begins during the first few minutes following the injury.

a. Normal signs and symptoms of inflammation include swelling, pain, reddening of the skin (**erythema**), and increased temperature in the affected area.

B. Acute Inflammatory Phase.

1. Trauma results in destruction of millions of cells. Initially, blood flow into the region is reduced (**vasoconstriction**), but after a few minutes, increased blood flow (**vasodilation**) occurs.

2. Damage to blood vessels results in blood flow into the interstitial spaces, resulting in **hematoma** formation. Hematoma is "localized collection of extravasated blood," an important step in the inflammatory process.

3. Decreased blood flow to tissue surrounding the injured area results in blood clotting, and in some cases, death of healthy cells because of oxygen deprivation (s*econdary hypoxic injury*). As cells die, they release lysosomes that degrade the cells.

4. Other chemicals are released that affect nearby cells. Substances that cause changes in nearby blood vessels produce vasodilation and vascular permeability. Chemotactic substances attract scavenger cells to the area (chemotactic effect).

a. **Histamine**, a powerful inflammatory chemical, is released from a variety of cells resulting in short-term vasodilation and increased vascular permeability.

b. Hageman factor (a substance in blood) becomes activated when tissues are damaged and induces many changes in the damaged area. This factor is responsible for the production of **bradykinin**, a powerful inflammatory chemical that increases vascular permeability.

c. The complement system is activated, which plays a role in attracting cells (chemotaxis) such as **leukocytes.** This is essential to the inflammatory process.

d. Bradykinin triggers the release of **prostaglandins** that have a number of effects within the damaged area including vasodilation, increased vascular permeability, pain, and blood clotting

e. As a result of increased vascular permeability, plasma proteins, platelets, and leukocytes move out of capillaries and into damaged tissue. Leukocytes dispose of damaged cells and tissue debris by **phagocytosis** (cell eating).

f. Short-lived neutrophils arrive at the injury site. When they die, they release chemicals that attract macrophages to the area. Macrophages also use phagocytosis to remove debris.

g. **Arachidonic acid** is produced by the action of enzymes supplied by leukocytes and from phospholipids that were in the membranes of destroyed cells. Arachidonic acid catalyzes the production of leukotrienes that attract leukocytes to the damaged area.

5. The acute inflammatory phase results in a "walling off" of the damaged area from the rest of the body and the formation of a mass of cellular debris, enzymes, and chemical attractants that serves to clean up debris and provide necessary components for tissue repair.

6. The acute inflammatory phase lasts up to 3 to 4 days, unless aggravated by additional trauma.

C. Resolution (Healing) Phase. This phase involves tissue repair.

1. Specialized types of leukocytes (polymorphs and monocytes) and a type of macrophage (histocytes) migrate into the area of damage, break down cellular debris, and set the stage for regeneration and repair.

D. Regeneration and Repair. With the exception of bone, all connective tissues heal by forming scar tissue that begins to form 3 to 4 days after the injury.

1. **Fibroblasts** migrate into the damaged area. Fibroblasts are immature, fiber-producing connective tissue cells that can mature into several different cell types.

2. Fibroblasts produce collagen fibers and proteoglycans, large protein molecules that help retain water in the tissues.

3. The damaged circulatory system begins to repair itself by **angiogenesis**, the formation of new capillaries, which interconnect to form new vessels.

4. The healing process can take up to four months and when completed under ideal conditions, scar tissue can be 95% as strong as the original tissue.

5. Stress is helpful to formation of strong collagen fibers in the new tissue. Thus, appropria rehabilitation exercises are critical to this process. Refer to Figure 8.2 on page 101 for the sequence of steps in the inflammatory process.

6. Bone tissue heals as specialized cells known as osteoclasts migrate into the region to remove cellular and other debris. Specialized fibroblasts (osteoblasts) migrate into the injured area from adjacent periosteum and bone.

a. Osteoblasts develop the callus, a zone of collagen and cartilage that is vascularized. The callus fills in the space between the fractured bone ends. Figure 8.3 on page 102 shows x-rays of a callus in a fractured bone.

VI. Pain and Acute Injury. Pain is often the major concern of the injured athlete, and everyone copes with pain differently. Pain is as much psychological as it is physiological.

A. As a physiological experience, pain results from sensory input (afferents) received and transmitted through the nervous system. Pain indicates the location of tissue damage.

1. Sensory information travels on relatively slow nerve fibers called nociceptive C fibers. Unlike other afferent nerve fibers, they are smaller and not myelinated. Myelination (fatty covering of nerve fiber) acts as an insulator and enables nerves to transmit information quickly.

2. Messages concerning sensory information that travels quickly to the CNS are given higher priority than messages that travel more slowly, such as pain.

B. A variety of **modalities** are used to treat pain. Refer to Table 8.1 on page 103.

C. Athletes with high pain tolerance may underestimate the severity of an injury; athletes with low tolerance to pain may overestimate the severity. Pain is not a useful indicator of the severity of an injury. However, coaches should be conservative, and when in doubt, refer the athlete to medical personnel because pain treatment is not the coach's domain. Coaches, parents, and athletes should not treat the pain associated with injury to enable the athletes to return to participation.

VII. Intervention Procedures. The sports medicine community has not provided a clear set of criteria for the first aid treatment of acute soft-tissue injury.

A. Suggested treatments for inflammation include **cryotherapy**, such as applications of crushed ice packs, commercially available cold packs, and aerosol coolants; ice cups applied by massage; and immersion in ice water baths.

B. After the acute inflammatory phase has passed, usually 48 to 120 hours following injury, **thermotherapy**, the therapeutic use of heat, may be appropriate. This modality includes commercially available hydrocolator packs, warm moist towels, and ulstrasound diathermy.

1. Modalities such as ultrasound should only be used under supervision of trained allied health personnel, such as an athletic trainer or physical therapist.

C. In addition to cold and heat therapy, pharmacologic agents to prevent swelling (**anti-inflammatories**) or control pain (**analgesics**) are often used. Most of these drugs are prescribed by a medical doctor and represent a form of treatment beyond the level of training of coaching personnel.

1. OTC drugs, such as aspirin, are effective for treating minor acute injuries, however, coaching personnel should use caution and consult parents when making recommendations to any athlete under the age of 18.

D. Cryotherapy and Thermotherapy. Changing the temperature of injured tissue can have dramatic effects on inflammation and healing. In the first few minutes after an injury, direct application of cold to an acute injury, usually crushed ice, may reduce vasodilation.

1. With extremity injuries, rest, ice, compression, and elevation (RICE) is standard first aid for sprains, strains, dislocations, contusions, and fractures.

a. Crushed ice placed in a plastic bag is inexpensive and highly effective. Commercially available chemical cold packs and aerosol sprays are less effective than crushed ice and can be dangerous.

1) The risk of **frostbite** from a bag of crushed ice is minimal; human tissue freezes around 25° F and an ice bag reaches a low of 32° F.

2) Recommended protocol for application of a crushed ice bag is 30 minutes, then removed for 2 hours, and then re-applied for another 30 minutes, if needed.

b. Compression is best achieved by using commercially available elastic wraps. The wrap also secures the crushed ice bag to the body. Care must be taken to avoid making the wrap too tight; you should be able to slip two fingers under the wrap after it has been secured.

c. Elevation is self-explanatory but when elevating a lower extremity, support adjacent joints with padding.

d. Do not risk aggravating injuries by performing tests such as ligament laxity assessments. Such testing should be performed by trained personnel.

2. Cold application can decrease the recovery time from an injury by reducing cells' metabolic activity, which lowers their need for oxygen.

a. Cold application also provides an analgesic effect and reduces muscle spasm.

3. Thermotherapeutic agents such as moist heat packs or ultrasound may have a beneficial effect on soft-tissue injury. Heat, however, should never be applied during the acute inflammatory stage because it increases inflammation. Thermotherapies stimulate vasodilation and are useful during the final stages of injury repair.

E. Pharmacologic Agents. Two groups of pharmacologic agents, steroidal and nonsteroidal anti-inflammatory drugs (NSAIDs), are available. Both groups interfere with the inflammatory process and reduce swelling or pain.

1. Steroidal Anti-inflammatory Drugs. Steroidal drugs resemble a group of naturally occurring chemicals in the body known as glucocorticoids. The exact mechanism of their action in inflammation is not well understood.

a. Steroids may decrease the amount of chemicals released by lysosomes, decrease capillary permeability, reduce white blood cell phagocytosis, and reduce local fever. The best known is cortisone; others include hydrocortisone, prednisone, prednisolone, triamcinolone, and dexamethasone.

b. Steroids may be taken orally, injected, or introduced through the skin by **phonophoresis** or **iontophoresis**.

c. Steroids must be used with care because they negatively affect collagen formation, and they can decrease connective tissue strength in the injured region.

2. NSAIDs do not have the negative effects on connective tissues of steroids. These drugs block the conversion of arachidonic acid to prostaglandin. NSAIDs are popular within the medical community; reportedly, 1.3 million NSAID prescriptions were written in 1991. Commonly used NSAIDs are listed in Table 8.2 on page 106.

a. Aspirin has anti-inflammatory, analgesic, and **antipyretic** effects.

b. Research has been inconclusive regarding the effects of NSAIDs on tissue healing and strength.

F. The best approach to caring for a soft tissue injury is the application of RICE during the acute inflammatory phase, followed by a combination of RICE, prescribed medications, and prescribed and properly supervised rehabilitative exercises.

VIII. The Role of Exercise Rehabilitation. The most effective treatment for many sports injuries is properly developed and supervised exercise.

A. Rehabilitative exercise has positive effects on collagen formation. **Collagen** is a major component of tendon and ligament tissues.

1. According to Knight, exercise increases circulation (O_2) to healing tissue and also stresses the tissue, and as a result, "guides" proper structuring of collagen.

2. Collagen formation and tissue regeneration requires 2 to 3 weeks. After the final phase of healing, the athlete should, when appropriate, have the area properly protected.

B. Rehabilitation programs must be planned by NATABOC-certified athletic trainer or a physical therapist with sports medicine training. Implementation and supervision of the exercise program usually are the responsibilities of the coach or physical educator.

C. Rehabilitative or therapeutic exercise is a four-phase process consisting of exercise categories based on a continuum of severity and recovery.

1. In cases of severe injury, reestablishment of ROM is accomplished by having a therapist move the injured extremity through a series of passive exercises. Passive exercise also reduces swelling and muscle spasm.

2. During the active assisted phase, the athlete improves ROM and muscle strength by making an effort to move the injured joint while being assisted by the therapist.

3. During the active exercise phase, the athlete continues to move the joint through full ROM and uses gravity as resistance to develop strength. The therapist supervises the exercising athlete.

4. Finally in the resistive phase, external resistance via manual resistance, exercise machines, or free weights improves the strength of muscles surrounding the injured area to protect it from future injury.

5. Injury rehabilitation is an ongoing process. Injury-specific exercise should be a permanent component of the athlete's total training and conditioning program. See Appendix 7 for more information about therapeutic exercise programs.