CHAPTER 3

Out of Harm's Way: Sports Injuries

After completing this chapter you should be able to:

- identify the factors associated with injury prevention;
- describe the common musculoskeletal injuries;
- demonstrate an understanding of the implications of various chronic and acute injuries and how to treat them.

The human body is designed to perform a wide variety of simple and complex movements and skills. Clearly, this ability relies on all its parts working together in harmony. An injury to one body part can disrupt the harmony of the entire body. Fortunately, many injuries are preventable.

With more people participating in sports and physical activity for health, fitness, and fun, avoiding injury is a notable concern. Many people ignore the warnings and risks that accompany certain activities, believing that nothing can possibly happen to them. Even the most careful physically active person can experience a mishap, but following some specific guidelines can greatly decrease your risk of sustaining an injury. Whether you make a concerted effort to improve your skills and technique when exercising, recognize the hazards that exist around you, perform proper conditioning exercises, or demand safe and quality equipment, you can enjoy an enhanced level of safety and confidence in your physical pursuits. You must take responsibility for your own actions by making appropriate decisions that reflect your safety and personal health (Figure 3.1).

Figure 3.1 Staying fit and active throughout your life requires attention to conditioning, healthy lifestyle choices, and safety.

Despite our efforts to take all of the necessary precautions, all dangers can never be completely eliminated; accidents do happen and injuries do occur. While most injuries are minor and not life threatening, knowing what to do if an injury occurs helps you deal with the situation quickly and correctly. An injury that is not cared for properly can easily escalate into a chronic problem that may plague your efforts to lead an active life.

Biomechanical Principles of Injury

The human body is made up of tissues or groups of cells that work together to perform a particular function. The four basic types of tissue are **epithelial** (e.g., skin), **muscle**, **connective** (e.g., tendons, bones, and ligaments), and **nervous**. Each type of tissue possesses unique mechanical characteristics. For example, bones are strong and stiff, whereas tendons are flexible so that joints can be mobile.

To best understand the biomechanical characteristics of tissue, we examine its behavior under **physical load** (see box *Forces Acting on Tissue*). Under load, a tissue experiences **deformation**. This change in shape phenomenon can be visualized in the load–deformation curve in Figure 3.2.

Did You Know?

When developing a prosthesis for human parts, such as a hip joint, biomechanical engineers ensure that the prosthesis can handle loads as well as or better than the human tissue it will be replacing.

Characteristics of the Load–Deformation Curve

- Loads occurring in the elastic region do not cause permanent damage.
- Permanent deformation will occur if loads exceed the yield-level point.
- The area under the entire curve represents the strength of the material in terms of stored energy.
- The slope of the curve in the elastic region indicates the stiffness of the material. Stiffness is the resistance to deformation, where the greater the slope of the curve, the greater the stiffness of the structure.

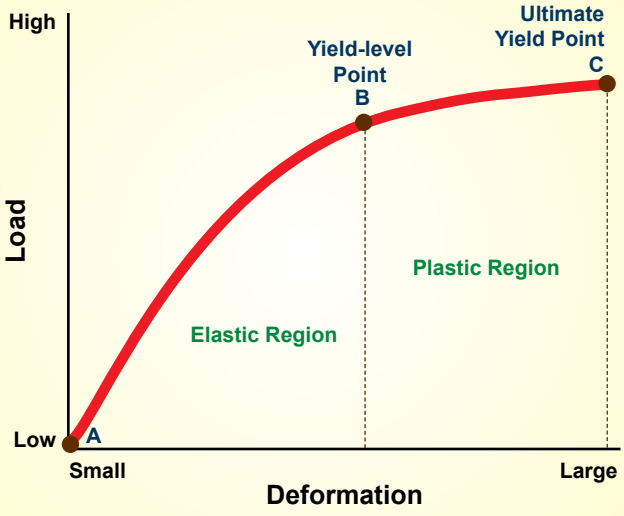


Figure 3.2 Load–deformation curve of a bone.

The A to B segment of the curve represents the **elastic region** of the tissue structure. Elasticity is the capacity of a tissue to return to its original shape after a load is removed. For example, when you push your finger into your thigh, the skin and the muscle underneath your finger become depressed. When pressure is removed, the tissues return to their original shape.

Point B on the curve (**yield-level point**) signals the **elastic limit** of the tissue, where the **plastic region** begins. In this region, increased loads cause permanent tissue deformation, resulting in micro-failure or injury to the tissue. Sprains and strains are good examples of such injuries. If the load continues to increase to the **ultimate yield point** (point C on the curve), **ultimate failure** of the tissue eventually occurs: a bone fracture or torn ligament. At this point the tissue becomes completely unresponsive to loads.

Tissue Responses to Training

Human tissue responds to training loads or stresses by becoming stronger. When training loads are at or near a tissue's *yield-level point* (Figure 3.2, point B), cells may divide to make new cells or to make proteins such as *actin*, *myosin*, *collagen*, or *elastin* to improve the mechanical properties of the tissue under **stress**. This muscle response is called the **positive training effect**.

Training overloads may cause microscopic injuries in various muscle regions, leading to sore muscles. In these situations, the muscle structures are *temporarily* weakened. It is important to let them recover before another workout. Research has shown that optimal training occurs at a level of tissue stress just below the yield-level point.

Injury Treatment and Rehabilitation

Treatment and rehabilitation are two directly linked aspects of recovery. During **treatment**, a patient receives care by a health care professional. Early and correct treatment promotes the healing process and improves the quality of the injured tissue(s), allowing the person to return to activity more quickly. **Rehabilitation** involves a therapist's physical restoration of the injured tissue along with the patient's active participation by following prescribed rehabilitation guidelines on his or her own.

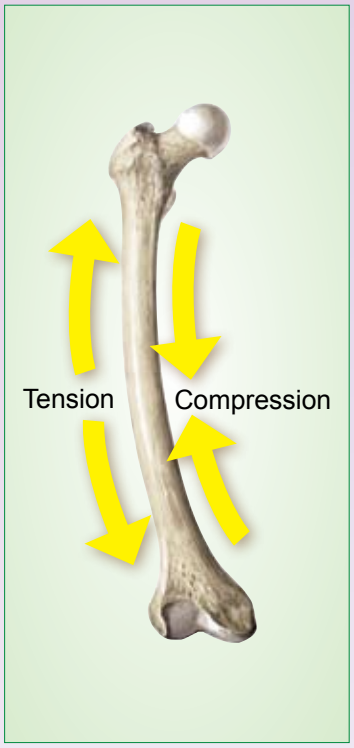
Although an individualized rehabilitation

Forces Acting on Tissue

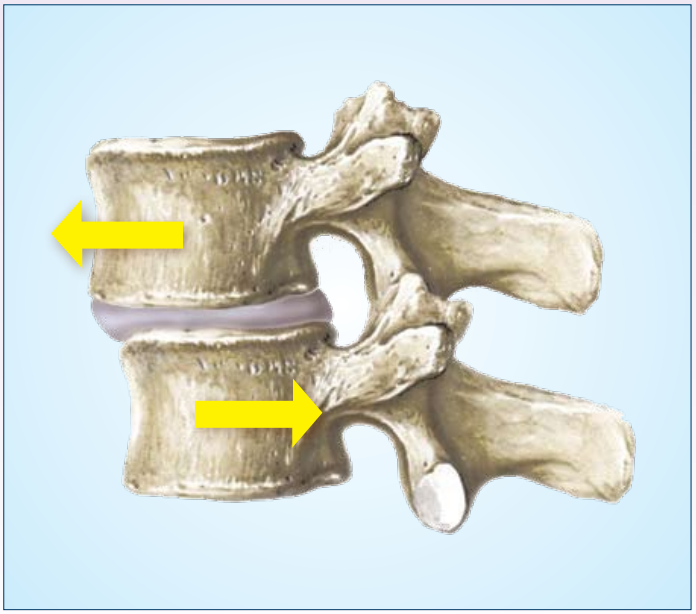
Tissue is exposed to a variety of physical stresses during physical activity. These stresses are forces and moments acting as directional loads that generate **tension** (pulling), **compression** (squeezing), **bending**, **shear**, or **torsion**.

Tension

Compression



Bending



Shear

Torsion

program should be created for each athlete, knowledge of general guidelines for early treatment and rehabilitation can be useful for dealing with acute injuries in particular. Some of these guidelines will be presented in this chapter.

Healing Phases

The healing process begins immediately after injury and consists of three overlapping phases: the inflammatory response phase, the fibroblastic repair phase, and the maturation–remodeling phase (Figure 3.3).

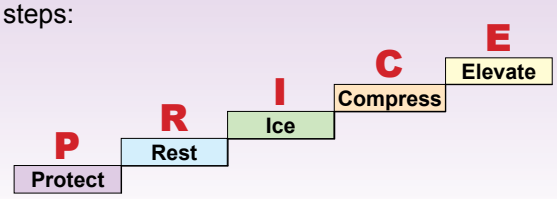
Inflammatory Response Phase

The **inflammatory response phase** sets the stage for tissue repair. Inflammation begins at the time of injury, or shortly after, and may last from two to four days. The injured area may show signs of redness, swelling, pain, increased temperature, and loss of function.

To allow healing to begin, the injury must be protected and rested. **Cryotherapy** (ice or cold water immersion for 15 to 20 minutes at a time) limits the amount of swelling and decreases bleeding, pain, and muscle spasms. **Compression** is applied over the ice, usually in the form of an elastic bandage. During cold water immersion, a compression bandage can be wrapped around the injured area. Finally, the area is elevated above the level of the heart to encourage the return of venous blood to the heart, thereby helping to decrease acute swelling and bleeding.

Follow the PRICE rule!

When dealing with an injury, follow these simple steps:



Fibroblastic Repair Phase

The **fibroblastic repair phase** leads to scar formation and repair of the injured tissue. It begins within a few hours of injury and may last as long as four to six weeks. A delicate connective tissue called **granulation tissue** forms to fill the gaps in the injured area. Fibroblasts produce **collagen fibers**, which are deposited randomly throughout the forming scar. In this second phase, many of the signs and symptoms seen in the inflammatory response subside.

During the fibroblastic repair phase, it is important to introduce controlled rehab-specific exercises that are designed to restore normal range of motion and strength to the injured tissue, as well as stressing the tissue to promote optimal tissue response (see box *Tissue Responses to Training*). Manual massage therapy and ultrasound help break down scar tissue. Protective taping or a brace is often used during this phase of rehabilitation.

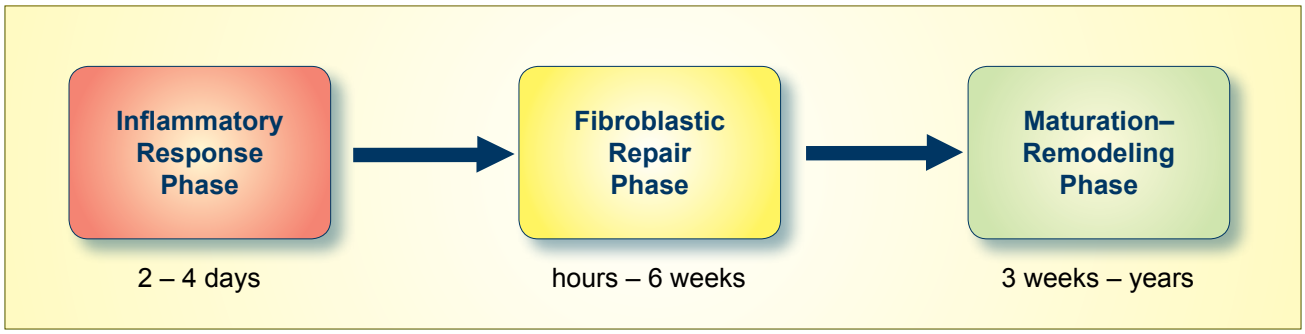


Figure 3.3 The three phases of the healing process.

Maturation–Remodeling Phase

The **maturation–remodeling phase** is a long-term process of remodeling or realigning the scar tissue. It begins about three weeks after injury and may continue for as long as several years. Stretching and strengthening become more aggressive in this phase because the goal is to organize the scar tissue along the lines of tensile stress. Sport-specific skills and activities are usually included in rehabilitation.

Pain: Nature's Warning System

Pain is nature's way of telling us something is wrong. However, many athletes ignore pain altogether. Professional athletes in particular believe that a little pain is natural, and taking a few days off to nurse an injury makes you weak and vulnerable. As a result, they choose to mask the pain with medication, which allows them to play through an injury. While the pain may subside, the problem remains unaddressed (Figure 3.4). Continued participation will push injured tissues closer to ultimate failure, resulting in a need for surgical repair. Other serious consequences of using medication to mask pain include addiction and gastrointestinal complications.

Figure 3.4 Pain medication helps reduce discomfort but fails to address the cause of the problem.

Having said that, the temporary use of certain medications to decrease pain and inflammation may be helpful and appropriate. One should always consult a physician prior to using any medication or supplement.

How long an athlete should rest an injury depends on the type and extent of the injury and also varies among individuals. Pain is one of the most important indicators of when it is best to resume play. We all feel it, we all know when it is present, and we all know when it has subsided. If it is painful to walk on a sprained ankle, whether one day after the injury or weeks later, it is simply too early to resume all-out activities. Once pain has subsided, training and competing may be introduced with caution. The load placed on an injured structure should increase gradually. Overloading an injured area, or coming back too early, can set you back longer than the original injury, and an acute injury may eventually become a chronic problem.

Soft Tissue Injuries

Contusions

When a compression force crushes tissue, a **contusion** results. Commonly called a bruise, symptoms include discoloration and swelling. What some athletes call a "charleyhorse" is a contusion injury, often to the quadriceps muscle group on the front of the thigh. While most

Myositis Ossificans

In a severe contusion, abnormal bone formation may occur. This is called **myositis ossificans**. The most common sites are the anterior and lateral thigh. A 1- to 1.5-inch (2- to 4-cm) mass is often palpable. Referral to a medical doctor is needed.

Management of a Quadriceps Contusion

Acute Phase (first 24 to 48 hours)

- Apply ice and compression with knee flexed at 120 degrees for 20 minutes each hour for a minimum of 4 hours.
- Begin pain-free passive or active range-of-motion exercises.

Subacute Phase (2 to 5 days)

- Continue with ice and compression.
- Continue active range-of-motion exercises.
- Begin partial weight-bearing activities.

Full Weight-bearing Phase

- Continue with ice and compression.
- Range of motion should be full.
- Slowly return to previous activities, and use protective padding to prevent reinjury.
- If there is still pain seek medical attention.

These are only general guidelines. Please consult a licensed health care practitioner for further details and individual situations.

contusions are minor injuries, they can be serious and even life threatening if the tissue involved is a vital organ such as the brain or kidneys.

Strains and Sprains

A **strain** occurs when muscle or tendon tissue is stretched or torn. A **sprain** results when a ligament or the joint capsule is stretched or torn, often from twisting movements or impacts that force the affected joints beyond their normal limits. Sprains and strains are classified into three grades based on the amount of damage to the tissues and the resulting pain and loss of function (Table 3.1).

Grade three sprains and strains result in complete rupture of the tissue and often require surgery. An example is an **anterior cruciate ligament tear**. The anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) crisscross the knee joint and give the knee stability. Of the two, the ACL is weaker and more likely to tear, often when changing directions rapidly or slowing down after running or landing from a jump as in basketball. A loud popping noise often accompanies an ACL tear, which is very painful. The knee joint gives out and swells very rapidly.

Common Strains

Common muscles strained in the lower extremities include the adductors (pulled "groin"), quadriceps, hamstrings, and hip flexors (iliopsoas). In the upper extremities, muscles of the rotator cuff, which help stabilize the shoulder joint, are often vulnerable to strains.

Hamstring Strains The hamstrings are the most frequently strained muscles in the body. The main mechanism of injury is rapid contraction of the hamstring muscles in a lengthened position. Most typically, this occurs during sprinting or running (Figure 3.5).

Weak hamstring muscles compared with

Table 3.1 Grades of strains and sprains.

Grade		Strain	Sprain
1st	Description	A few muscle fibers have been stretched or torn	Ligament has been slightly stretched or torn
	Pain	Minor pain during isometric and passive movements	Minor pain during passive movements
	Range of motion	Decreased	
	Swelling	Minor	
	Weakness	Minor	
	Disability	Little or no loss of function	
2nd	Description	More muscle fibers have been torn	Ligament has been moderately stretched or torn
	Pain	Moderate pain during isometric and passive movements	Moderate pain during passive movements
	Range of motion	Decreased	
	Swelling	Moderate	
	Weakness	Moderate	
	Disability	Moderate loss of function	
3rd	Description	Muscle is completely torn	Ligament is completely torn
	Pain	No pain during isometric and passive movements*	
	Range of motion	May increase or decrease depending on swelling	
	Swelling	Major	
	Weakness	Major	
	Disability	Major	

* *When you completely tear a muscle, tendon, or ligament, the ability to feel pain in those structures is completely lost.*

Artificial Turf Versus Natural Turf

There is much debate about whether artificial playing surfaces are more dangerous than natural playing surfaces. Artificial surfaces provide greater friction, enabling athletes to run faster and change directions more quickly. However, these conditions also increase the loads placed on muscles, tendons, and ligaments, increasing the likelihood of sustaining a strain or sprain. Therefore, a trade-off exists between performance and potential for injury on artificial surfaces.