I Overview

CHAPTER

1

Integrated Injury Management

Musculoskeletal trauma can be an unfortunate consequence of physical activity. When tissues are traumatized, a series of events are triggered that influence the patient's return to activity. Although the primary tissue destruction has already occurred, the initial and follow-up management affect the healing process.

The proper course of postinjury management depends on obtaining a correct diagnosis. The initial diagnosis—which is often made immediately after the traumatic event—has two purposes: (1) to determine whether the patient requires immediate transportation to a medical facility and (2) to decide which procedures will be required to protect the injured body part while the patient is moved, so a more thorough evaluation can be conducted. Furthermore, in catastrophic instances, emergency medical procedures may need to be performed to preserve the patient's life, limbs, or neurologic function.

A definitive diagnosis is based on careful analysis of the findings of the clinical evaluation, imaging studies, and, when applicable, medical diagnostic tests. Some conditions are readily apparent on simple visual inspection, whereas further diagnostic testing may be needed to identify confounding structural defects, rule out concomitant trauma, and determine the functional integrity of the surrounding tissues. When definitive findings are present, the final diagnosis may be established by excluding other possible conditions, the differential diagnosis.

Discerning a differential diagnosis comprises a systematic method of examining a condition that lacks unique signs or symptoms, has signs and symptoms that closely resemble multiple conditions, or has signs and symptoms that can mask another injury. Due diligence mandates that all other possible maladies be considered and ruled out before the final, definitive diagnosis is reached. Similarly, if an injury does not respond to treatment as anticipated, a complete reexamination should be conducted and the patient referred to an appropriate specialist if applicable.

Between the initial diagnosis of the condition to the full return to activity, several different providers—physicians, athletic trainers, physical therapists, and strength and conditioning specialists—may be involved in the patient's care. The size and composition of the caregiving team will depend on the nature of the injury, geographic barriers to care, and the patient's ability to pay for these services (i.e., healthcare insurance). The efforts of these various providers must be part of a coherent and coordinated plan, with each understanding the patient's pathology, functional limitations, and level of function, as well as the other providers' roles in this process.[1]

Pathomechanics and Functional Limitations After Injury

Traumatized or improperly healed tissues can lead to the alteration of a joint's normal biomechanics (pathomechanics). With time, this pathomechanical change may disrupt the normal function of other joints and muscle groups along the **kinetic chain**, leading to disability.

Injury to ligaments and joint capsular structures can produce instability during movement as the joint fails to maintain its optimal position, causing weakness and inhibiting normal biomechanics. Prolonged alterations of normal range of motion (ROM) result in compensatory postures, increasing the amount of stress placed on the other joints and muscles. The ensuing biomechanical changes lead to functional shortening of some tissues and elongation of others, creating imbalances in muscle length and strength. Subsequent pathomechanical changes may include muscular **compensation** or **substitution**.

kinetic chain A series of body parts linked together by joints and muscles through which action/reaction forces are transmitted.

compensation Changes in biomechanical function to overcome muscular weakness or joint dysfunction.

substitution A secondary muscle or muscle group performing the action that would otherwise be performed by a primary muscle.

Imaging Techniques

The role of diagnostic imaging in the evaluation process has significantly increased during the past decade. Diagnostic imaging was once primarily limited to the inclusion or exclusion of bony defects (including joint malalignment). More recently, advances in radiographic imaging techniques, nuclear medicine, and computer technology have expanded the imaging modalities available to physicians, including magnetic resonance imaging (MRI) and computed tomography (CT) (see **Figure 1.1**). Diagnostic ultrasound is a useful diagnostic tool for identifying tendinous lesions and soft-tissue masses and cysts.

The views obtained for each body area are relatively consistent for each imaging modality (see **Table 1.1**). Limitations do exist and multiple views—or multiple imaging devices—are often required to obtain accurate images of the involved area.

Radiographs

Radiographic images are obtained by passing an x-ray beam through the tissues. The x-ray energy is collected on a film cassette or digitally (digital

Figure 1.1 Comparison of imaging types. (**A**) Anteroposterior radiograph of a posterior hip dislocation (white arrow). The black arrow indicates the acetabulum; the white arrowheads identify fracture segments. (**B**) An axial CT scan of the hip shows an intra-articular fracture (white arrow) that was not visible on the radiograph in (A). This scan can be "windowed" to better illustrate soft tissue but at the expense of bony images. (**C**) Coronal T1-weighted MRI of a femoral neck fracture.

or computed radiography). On a gray-scale continuum, radiographic images are white in areas of high x-ray uptake (primarily bone), filtering down to black in areas where no x-ray energy is absorbed by the tissues. Although skin, adipose tissues, some degree of soft tissue, and, in certain cases, edema or hemorrhage can be identified on radiographs, their quality and contrast resolution are often insufficient to make a definitive diagnosis. For bony defects, however, radiographs are the most sensitive imaging modality, capable of detecting objects as small as 0.05 to 0.1 millimeter (depending on the equipment used), compared with 0.4 to 1 millimeter on high-resolution CT scans.[2] Another limitation of radiographs is their two-dimensional views. Fluoroscopy is the process of obtaining radiographic images in real time, allowing for visualization of joint kinematics and guidance during surgical procedures.

Magnetic Resonance Imaging

In MRI, a strong static magnetic field with intermittent radiofrequency (RF) pulses is delivered to the tissues to form an image of the internal tissues. A powerful magnetic generator affects the hydrogen atoms that are found in all tissues. Similar to what happens in a compass, these atoms align with the magnetic field. When a brief (millisecond) RF pulse is introduced, the atoms are deflected from their axis. When the RF pulse terminates, the atoms wobble as they become realigned with the magnetic field, in the process emitting weak RF signals of their own. Atoms in different types and densities of tissues realign themselves at different rates,

Table 1.1

Routine Imaging Views by Body Area

Upper Extremity	
Fingers	PA, lateral, oblique (fingers should be separated)
Hand	PA, oblique, lateral
Wrist	PA, lateral (both with neutral positioning)
Forearm	AP, lateral
Elbow	AP (supinated), lateral (90° flexed); oblique views may be added for trauma patients
Humerus	AP, lateral
Glenohumeral joint	AP in internal and external rotation, true AP of the scapula, axillary; a 30° caudal tilt view is added for suspected impingement; a transscapular view is helpful in assessing glenohumeral dislocation and acromion morphology
Acromioclavicular joint	AP, 10° cephalad AP (Zanca view)
Lower Extremity	
Hip	AP internal rotation, frog lateral (or cross-table lateral)
Femur	AP, lateral
Knee	AP, lateral (30° flexion)
Knee: arthritis	Add AP weight-bearing views or PA flexed weight-bearing views, lateral weight-bearing views, and occasionally Merchant axial views
Knee: intercondylar notch	Tunnel view (angulated PA or AP 45° flexed)
Patellofemoral joint	Merchant view
Lower leg	AP, lateral
Ankle	AP, lateral, mortise
Foot	AP, lateral, medial (internal) oblique (weight-bearing AP and lateral for foot alignment abnormality)
Subtalar joint	Lateral view, posterior tangential
Calcaneus	Lateral, AP, axial
Toes	AP, lateral, AP oblique
Axial Skeleton	
Cervical spine	AP and lateral views; a lateral flexion-extension view can be added in patients with rheumatoid arthritis and suspected instability; a trauma spine series should include an open mouth odontoid view and a swimmer's view if C7 is not visualized
Thoracic spine	AP, lateral
Lumbar spine	AP, lateral
Sacrum	30° cephalad angulated AP, lateral
Coccyx	10° caudal angulated AP lateral
Sacroiliac joint	30° cephalad angulated AP (Ferguson view)
Pelvis	AP (Judet view and/or inlet/outlet views for pelvic ring fractures)

PA indicates posteroanterior (ie, beam of x-ray originates from the patient's posterior and travels to the anterior); AP, anteroposterior (ie, beam of x-ray originates from the patient's anterior and travels to the posterior).

Source: Reprinted with permission from Johnson TR, Steinbach LS (eds), *Essentials of Musculoskeletal Imaging*, Rosemont, IL: American Academy of Orthopaedic Surgeons: 2004:6.

producing a magnetic resonance signal. These signals are collected by the unit and reconstructed into relatively high-resolution, high-contrast images by a computer and its software.

MRI excels in imaging soft tissue and is sensitive enough to detect stress fractures more acutely than radiographs. This imaging technique is clearly superior in detailing soft tissue such as ligaments, cartilage, tendons, and muscles. In some instances, a contrast medium may be injected into the tissues to improve the quality of the image. The individual RF properties (spin echo) of different tissue types can be filtered to accentuate different tissue types (see **Table 1.2**). Depending on the weighting used—T1, proton density, or T2—the tissue resolution is altered for more or less prominence (see **Figure 1.2**).

Most MRI scans take 20 to 60 minutes. In addition, a potential complication exists if the patient

Table 1.2

Relative Signal Intensities of Selected Structures on Spin Echo in Musculoskeletal Magnetic Resonance Imaging

Structure	Sequence: T1-Weighted	Sequence: Proton Density	Sequence: T2-Weighted
Fat*	Bright	Bright	Intermediate
Fluid†	Dark	Intermediate	Bright
Fibrocartilage‡	Dark	Dark	Dark
Ligaments, tendon§	Dark	Dark	Dark
Muscle	Intermediate	Intermediate	Dark
Bone marrow	Bright	Intermediate	Dark
Nerve	Intermediate	Intermediate	Intermediate

*Includes bone marrow.

†Includes edema, most tears, and most cysts.

‡Includes labrum, menisci, triangular fibrocartilage.

§Signal may be increased because of artifacts.

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Figure 1.2 MRI tissue weighting. (**A**) A sagittal T1-weighted image demonstrating bone marrow edema (arrow) consistent with a stress fracture. (**B**) A sagittal proton-density-weighted image demonstrating thickening of the patellar tendon (arrow) consistent with patellar tendinitis. (**C**) A sagittal T2-weighted, fat-suppressed image demonstrating a tear within the proximal patellar tendon (arrows). The altered signal intensity above the arrows indicates edema.

is claustrophobic and a closed (tubelike) scanner is being used. Metal within the magnetic field is of particular concern. Most implanted metal is MRI compatible, but other metals can be affected by—and violently pulled toward—the magnet. MRI of areas with certain tattoo inks that contain metal can cause burns.[3]

Computed Tomography

CT scans use thin x-ray beams that are passed through the body and read by multiple detectors. Similar to radiographs, the amount of x-ray energy received by the detector is a function of the tissue density through which the beam passes, but the CT scan also detects the amount of energy scattered by the tissue. Selected soft tissues such as joint spaces and vasculature can be imaged by injecting a contrast medium.

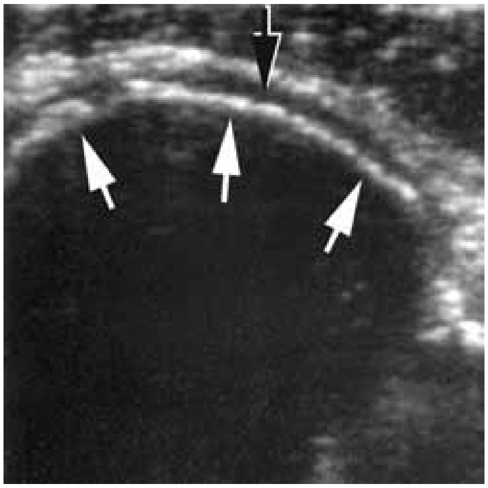
The final image is formed by computer analysis and manipulation of the energy collected by the detector. Contrast resolution is superior to that obtained via plain-film radiographs, and the grayscale continuum can be digitally altered to display only those tissues that fall within a defined density range ("windowing"). Different views, or slices, can be extracted to create an image of the body part in various planes. Some CT scanners can construct three-dimensional images.

CT scans are primarily used to identify cortical bone, bony lesions that are not normally visible on radiographs, and (using a contrast medium) joints. This technology, however, lacks the contrast needed to image most soft tissues.

Diagnostic Ultrasound

Diagnostic ultrasound transmits high-frequency sound waves into the tissues. Diagnostic ultrasound uses a lower frequency than therapeutic ultrasound, however, and it does not heat the tissues. Depending on the density and consistency of the underlying tissues, the sound waves then are reflected back at different speeds and amplitudes. This information is collected by a receiver and transmitted to a computer, where it is reconstructed to form an image. Doppler ultrasound is used to detect motion, particularly in vascular studies.

Dense, highly reflective tissues appear white on the ultrasonic image, whereas less reflective tissues appear darker (see **Figure 1.3**). False-positive readings of tendon lesions may occur if the ultrasonic energy does not strike the tissue at a right angle.[4] Although ultrasonic images allow for better spatial resolution than CT or MRI, the interpretation of these images depends more on the skill and experience of the individual reading them.



A

B

Figure 1.3 Ultrasonic images of a glenohumeral rotator cuff tear. This transverse bilateral view demonstrates a massive rotator cuff tear of the right shoulder (black arrow). The supraspinatus tendon is not visible on the upper image (**A**) but is visible on the lower (**B**) (white arrowhead). Also note that the humeral head on the upper image (white arrows) is riding higher than that on the lower image.

Therapeutic Medications

Both prescription and nonprescription medications are useful during the short- and long-term care of patients with musculoskeletal injury. These medications alter the inflammatory response, control pain, prevent infection, and reduce muscle spasm. Anti-inflammatory agents, **analgesics**, **anesthetics**, **antibiotics**, and **antiseptics** are among the medications most commonly used in orthopaedics and sports medicine. Considering the frequency with which these agents

analgesic Pain-relieving without the loss of consciousness.

anesthetic Loss of sensation; may be local or general (body-wide).

antibiotic Used to kill bacteria that cause infection.

antiseptic Inhibits the growth of disease-producing microorganisms.

are used and the potential harm that can occur if they are used inappropriately, an understanding of their mechanisms of action, common adverse effects, and potential drug interactions is essential.

Medications presented in this text include both prescription and over-the-counter (OTC) products. Prescription medications also are called "legend drugs" because they carry the following federal warning (or legend) on the package:

> **CAUTION:** Federal law prohibits dispensing without a prescription.

A comprehensive resource for commonly used medications should be available to every healthcare provider. Among the more commonly used drug references are *The Physicians' Desk Reference* (PDR), *American Hospital Formulary Service Drug Information,* and *Drug Facts and Comparisons*. These references should be consulted whenever questions arise about drug interactions, contraindications for use, adverse effects, and instructions for administration. In addition, all sports medicine personnel should have on hand the most current lists of banned medications maintained by the various sport-regulating bodies, such as the National Collegiate Athletic Association, the U.S. Olympic Committee, and the International Olympic Committee. These lists can be accessed via the Internet and should be reviewed frequently so updates are not missed.

Medication administration is the direct application of a single dose of a drug, whereas dispensing a drug is the "preparing, packaging, and labeling of a drug or device" for patient use.[5] Most states have strict regulations for drug administration and dispensing. Box 2.1 (in Chapter 2) describes commonly used anti-inflammatory and analgesic medications while Box 2.2 describes commonly used antibiotic medications.

Routes of Drug Administration

The primary routes for delivering drugs to the body include enteral, parenteral, and topical administration (see **Table 1.3**). Drug delivery through the skin can be enhanced by application of a low-level electric current (iontophoresis) or ultrasound (phonophoresis). Although these clinical techniques are widely used, their efficacy has not been substantiated.

Iontophoresis uses a low-amperage direct current to drive ions from drug solution into tissue. This technique is used to treat musculoskeletal inflammatory disorders with nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroids, and other medications. Iontophoresis treatment regimens (measured in milliampere-seconds of current) vary depending on the medication used and the condition being treated (see **Figure 1.4**).[6]

Phonophoresis is the application of therapeutic ultrasound to increase drug delivery through the skin.[7] In this technique, ultrasonic energy is transferred through a medium capable of transmission. The ultrasonic waves have two primary physical consequences within the skin—heating and cavitation. The overall result is increased skin permeability, which enhances drug diffusion through the skin. Although a variety of medicinal agents have been administered via phonophoresis, hydrocortisone and dexamethasone are the agents most frequently used for treating musculoskeletal injuries.

Table 1.3

Methods of Drug Delivery into the Body

Route	Method
Enteral	Oral. Sublingual (under the tongue). Rectal.
Parenteral	*Subcutaneous* injection into the subcutaneous tissue under the skin that overlies muscle. The medication is absorbed slowly via this delivery method, thereby delaying the onset of drug action. *Intramuscular* injection directly into muscle tissue. *Intravenous* injection in the form of an intravenous bolus or a slower intravenous infusion. Medications delivered via this route have a rapid onset of action.
Topical	Applied to the skin and absorbed into the underlying tissues. This method reduces the risk for systemic side effects and focuses the agent's effects at the site of inflammation.

Figure 1.4 The iontophoresis technique uses a low-amperage direct current to introduce NSAIDs or corticosteroids into the subcutaneous tissues.

Postinjury Management

Postinjury management encompasses the nonsurgical, preoperative, and prehabilitation injury care that occurs after the immediate management of the injury and after acquiring a working diagnosis of the injury. Examples of postinjury management include suturing and the closed reduction of fractures and dislocations (see Chapters 2 and 3).

Most postinjury management involves the continued use of ice, compression, and elevation. If indicated, an immobilization device is obtained and applied, splinting the extremity in a specific position and/or restricting a certain ROM.

Crutches

Crutches and, on occasion, canes are used to reduce or eliminate lower extremity weight-bearing forces. The two primary forms of crutches used in orthopaedic medicine are full-length and forearm crutches. Forearm crutches run only to the forearm, but require greater upper extremity strength and better balance than full-length crutches.

Full-length crutches are fitted by placing the tips 4 to 6 inches anterior and lateral to the foot and adjusting the length to allow 2 to 3 inches of clearance between the axilla and the top of each crutch. The hand grips are adjusted so that the elbows are flexed to approximately 30°. The body weight should be borne on the hands rather than the axillae. Improper crutch mechanics that place the body weight on the axillae can result in axillary nerve neuropathy.

Crutches can be used for either non-weight-bearing (NWB) mobility or partial-weight-bearing (PWB) mobility. When the patient is instructed to remain NWB, the crutch and injured extremity move in unison during normal ambulation. When ascending stairs, the patient leads with the good leg; when descending stairs, the involved leg leads (remembered by "up with the good, down with the bad"). When the patient engages in PWB behavior, the involved extremity and crutches move together, but the patient bears as much weight as tolerable on the injured leg. The amount of pressure used must still allow for a proper heel–toe walking gait. If the gait is improper, the patient should be instructed to decrease the amount of pressure on the involved leg.

A cane should be held in the hand opposite the side of the injury, and the length should be adjusted so the elbow is flexed to 20° to 30° when the tip is placed 6 inches in front and 6 inches to the side of the foot. When the patient is walking, the cane moves forward with the involved extremity. If the patient leans or places too much weight on the cane, then two crutches should be used.

Prehabilitation

Prehabilitation is the use of rehabilitation exercises prior to surgery. The goal of prehabilitation is to maximize the strength of the surrounding muscles and increase joint ROM within tolerable limits before the patient undergoes the physical stress of surgery. Because the patient goes into the surgery with the involved extremity strong and with increased ROM, the postsurgical rehabilitation starts at an advanced point (relative to the patient with no prior conditioning) and prevents postoperative complications. Prehabilitation that addresses ROM normalization in patients with acute anterior cruciate ligament injuries, for example, significantly decreases the incidence of arthrofibrosis after reconstruction.

Bracing

A variety of braces are commercially available and can be found for virtually every joint of the body. Braces are classified into three categories: rehabilitative, functional, and prophylactic.[8] Rehabilitative braces are designed to provide protection and control motion during the healing and rehabilitative phases after injury or surgery. Functional braces allow motion and support the joint as the patient is returning to activity. These braces, which provide protection to the injury without hindering motion, include derotation braces, patellar stabilization braces, and ankle braces. Prophylactic braces are intended to provide protection against potentially injurious forces. Other forms of support include specific pads and orthotic devices that can help protect injured structures or shield them from injury.

Splinting and Casting

Made of plaster, moldable plastics, or fiberglass, splints cover only two or three sides of the extremity, are used for relatively short-term immobilization, and can be easily removed for treatment or evaluation. Braces and immobilizers also can be used to splint a body part. Casts completely surround the joint and are worn for extended periods.

The following general considerations are important in the application of splints and casts:[9]

1. Clothing should be removed from the area of any suspected fracture or dislocation to inspect the extremity for open wounds, deformity, swelling, and ecchymosis.
2. Any jewelry items are removed immediately if possible, including finger and toe rings.
3. The pulse, capillary refill, and neurologic status distal to the site of injury are noted and recorded. If pulses are compromised, reduction should be attempted and the patient immediately transported to an emergency care facility.
4. All wounds should be covered with a dry sterile dressing before a splint is applied. The physician should be informed of all open wounds in case further evaluation is necessary.
5. The splint should immobilize the joints above and below the suspected fracture.
6. With injuries in and around the joint, the splint should immobilize the bones above and below the injured joint.
7. All rigid splints should be padded to prevent local pressure.
8. Clinicians should use their hands to minimize limb movement and support the injury site until the splint has been placed and the limb is completely immobilized.
9. A severely deformed limb should be aligned with constant, gentle manual traction so that it can be placed in a splint.
10. Check the pulses and neurologic status after the alignment.
11. If resistance to limb alignment is encountered when applying traction, the limb should be splinted in the position of deformity.
12. When in doubt, splint the limb, monitor neurovascular status, and arrange for transportation to an emergency care facility.

Surgical Intervention

Surgical intervention is indicated when an injury will leave lasting consequences of functional deficits and restoration of the anatomy will improve the prognosis and functional outcome. Although surgery is a restorative process, the scalpel's contact with the tissues creates additional trauma. The fact that this trauma is created in a controlled environment does not negate the ensuing inflammatory response and the short- and long-term functional limitations associated with surgery. The choice of timing of the surgical intervention, the surgical procedure used, the severity of the condition, and the surgeon's skill all influence the postoperative care, rehabilitation protocol, and long-term outcomes, as do the patient's ability and willingness to comply with the postoperative program.

Most orthopaedic surgical procedures have very specific influences on activity progression and functional limitations that must be adhered to when designing the rehabilitation program. These limitations are highly individualized and can vary even with similar procedures; they can be surgeon-specific, procedure-specific, and injury-specific. If questions exist regarding the indications and contraindications of rehabilitation techniques, clarification should be obtained from the physician to facilitate complete commitment to the postoperative protocol.

Postoperative Management

The immediate postoperative care involves protection of the repair and care of the surgical wound. Protecting the repair (including reconstructions and fixations) includes limiting the stress on the skin closure by immobilization with bracing, casting, splinting, or wrapping. After lower extremity surgery, NWB or PWB crutch ambulation is often necessary to protect the surgical site.

Basic postoperative wound care is directed at preventing contamination of the incision and optimizing the tissues' healing environment by limiting swelling and inflammation. Basic ice, compression, and elevation principles are employed. Clean wound care techniques and dressing changes help prevent contamination. The incision should be kept dry to avoid skin maceration and contamination. Sutures or staples are removed only after adequate healing has been demonstrated, usually a minimum of 7 to 14 days after surgery.

As healing progresses and it becomes safe to start mobilization, controlled passive and active ROM exercises are started. Once motion has been normalized, a comprehensive progressive resistance exercise program is begun. This program is accompanied in the later phases of postoperative care by cardiovascular conditioning activities. Functional evaluations determine progression to the next phase of rehabilitation and return to play.

Table 1.4

General Rehabilitation Goals
Control inflammation, swelling, and pain.
Restore range of motion.
Restore strength.
Restore neuromuscular function.
Restore power and endurance.
Regain full function.
Return to pain-free activity.

Injury-Specific Treatment and Rehabilitation Concerns

The principles of rehabilitation are founded on an understanding of anatomy, pathophysiology, biomechanics, and tissue healing. Better incorporation of biomechanics and improvements and changes in postinjury and surgical techniques have allowed for accelerated rehabilitation programs. These changes have been made possible through sound scientific studies and continual reevaluation of the outcomes.

General rehabilitation goals appear in **Table 1.4**. Most injuries have specific concerns that must be addressed during the rehabilitation program. Similarly, surgical procedures place short- and long-term limitations on the rehabilitation techniques that can be employed with specific patients.

Although rehabilitation goals are presented sequentially in Table 1.4, in practice there is considerable overlap of goals and the specific rehabilitation protocols used to address the problems within each area (see **Figure 1.5**). The physiologic ability of the patient to properly and completely perform any given exercise should be the criterion applied to progress through that activity. The exercises should be performed without compensation or the risk of injuring the healing tissues. Use of criterion-based progression allows patients to advance, if activity can be tolerated, yet protects patients who are not physically ready to move forward in the rehabilitation program.

If permitted by the physician during the convalescence period, the patient should exercise the uninvolved extremities. A stationary bicycle, stair stepper, or elliptical trainer can be used if the upper extremity is involved (and for certain lower extremity injuries). If the patient is unable to bicycle or bear weight, an upper body ergometer can be used to maintain cardiovascular endurance.

Amount of Time Lost

The estimated amount of time lost is an average of the time loss for patients with similar conditions. Although the minimum amount of time required to recover from an injury is more easily predicted, the maximum recovery time is affected by numerous other variables, such as the severity of the injury, the patient's age, the vascular integrity in the healing tissues, nutrition, medication, and steroid use. Older patients with reduced cardiac function require a longer time for recovery. Poor nutrition or anabolic steroid use also may delay healing.

Another factor influencing the recovery time is patient compliance. With regard to the rehabilitation program, home-care instructions and activities to avoid should be carefully identified. Noncompliant patients can increase the amount of time needed to return to activity if they do not follow through with home rehabilitation instructions, thereby delaying the anticipated progression. Failure to adhere to activity limitations, such as avoiding weight bearing, can further injure the tissues and delay the healing process.

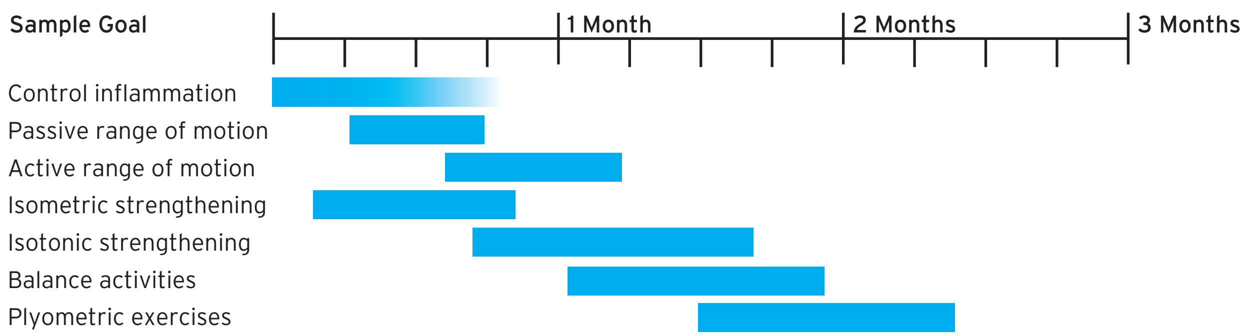


Figure 1.5 A sample rehabilitation sequence. The individual components (goals) of the rehabilitation progression often overlap.

Return-to-Play Criteria

Before returning to sports participation or other strenuous activity, the patient should be pain free; demonstrate bilaterally equal strength, ROM, and proprioception; and be able to perform sport-specific or work-specific tasks. Muscle strength should be at least 85% to 90% of that in the uninvolved extremity.

The athlete should be able to perform all sport activities such that an observer would be unable to identify the extremity that had been injured, and the athlete should display confidence in himself or herself and the injured segment. Athletes should also be psychologically prepared to return to activity, demonstrating confidence in their ability to perform appropriately. Once all of these factors are satisfied, return to activity may be allowed. Return to play should start in controlled situations with the athlete's own team and in friendly confines in a practice and scrimmage situation.

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